DRILLING AND PRODUCTION

PIPE LINE

REFINING NATURAL GASOLINE

OBVIOUSLY a silly question . . . but it obviously is not silly to recognize that high octane motor fuels, lubricating stocks and virtually all the products of petroleum daily are becoming more vital to defense. As higher degrees of production efficiency are attained in the building of planes, tanks and ships, the demand for increased efficiency in all phases of petroleum production must follow. Tret-O-lite compounds, advisory service and research have been developed to assure efficient and economical treatment of emulsions. For top dehydrating efficiency, call your Tret-O-lite representative.

TRETOLITE COMPANY

Manufacturing Chemists

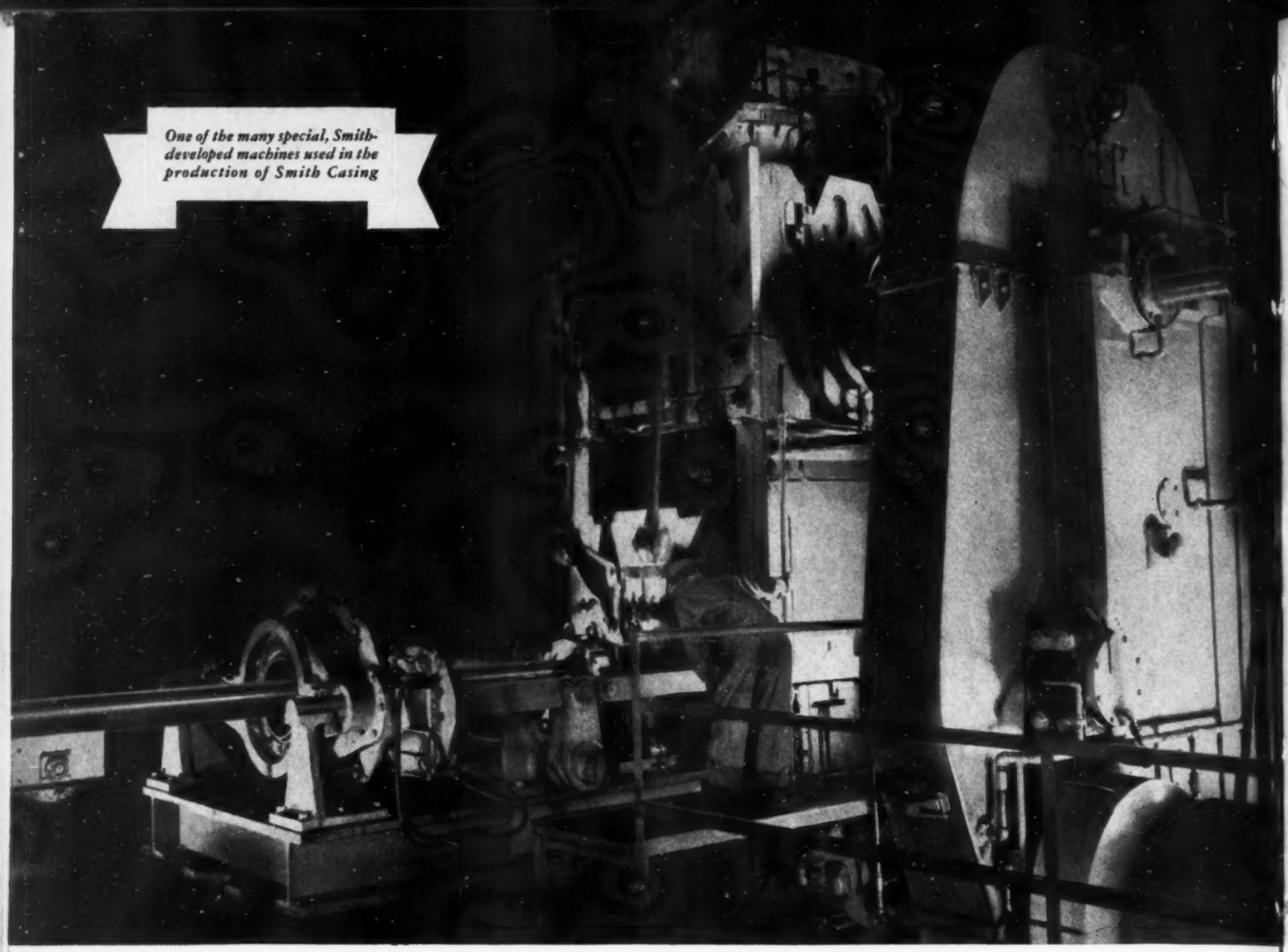
WEBSTER GROVES, ST. LOUIS COUNTY, MISSOURI • LOS ANGELES, CALIFORNIA

Tret-O-lite

REG. U. S. PAT. OFF.

DEHYDRATING DESALTING

Representatives in All Principal Fields



One of the many special, Smith-developed machines used in the production of Smith Casing

There are no priorities on ideas!

Although steel for making Smith Casing is not available now except on priority orders, *there are no priorities on ideas*, the other essential ingredient of Smith Casing.

It was ideas which sired the Smith Casing you've known . . . the casing which saves steel and dollars because, during manufacture, its strength is increased without increase in weight.

Now *new* ideas are being born! For in solving the unprecedented problems of wartime production, Smith engineers are successfully devising even better, faster, and more economical ways to make things out of steel.

And it is these ideas which will give you even better Smith Casing in the future than you've used in the past.

• • •

Offices at New York, Pittsburgh, Chicago, Tulsa, Dallas, Shreveport, Houston, Los Angeles, Seattle.

ELECTRIC-WELDED CASING

A. O. SMITH Corporation

MILWAUKEE • WISCONSIN

This is number 10 in a series of informative articles prepared by Macwhyte Wire Rope Company. The purpose of this series is to help wire rope users in these critical times to get the longest possible service from present ropes . . . through making useful facts on rope care more widely known.

CORROSION IN WIRE ROPE

Corrosion is one of wire rope's worst enemies. It strikes without warning. It often reaches an advanced stage before being noticed. And even though checked it still leaves its imprint of destruction.

We can better understand corrosion (and how to prevent it) by knowing what it is, what causes it, where and when it is likely to strike.

What Corrosion Is

The dictionary defines corrosion as "an action of eating or wearing away by slow degrees; a gradual decay by crumbling or surface disintegration; a gradual breaking down of the material attacked."

Two General Classes

There are two distinct types of corrosion:

Acid corrosion, and

Alkaline (or salt) corrosion.

In the case of acid corrosion the wires become pitted and stress concentrates at the reduced cross-sections where pits are located. This causes premature failure of the rope.

In the case of alkaline, or salt corrosion, the wires become encrusted with a layer of the products of corrosion. The rope becomes rust bound, for example. Alkaline corrosion increases the size and weight of the steel wires.

Acid and alkaline corrosion both may occur when ropes are operating in (or subjected to) ordinary atmosphere or weathering, or special conditions which subject the rope to either acid or alkaline substances.

What Happens When Corrosion Sets In?

When this occurs the rope loses its flexibility. Then some of the wires are overloaded, which causes them to break. This is the "beginning of the end" for the entire rope. It starts to wear away rapidly.

No Way To Determine Rope's Safety Once Corrosion Sets In

Corrosion, probably the most severe type of deterioration, is the most difficult to evaluate. Ordinarily when internal corrosion has taken place, external corrosion is also present. But it is impossible to accurately estimate by any known means the remaining strength or safety factor of the rope once corrosion has set in.

More Information

The next advertisement in this series prepared by the Macwhyte Wire Rope Company will discuss ways of preventing corrosion, or in those cases where corrosion has gotten a start how to check it from doing further damage.

Feel free to write us on this, or any problem you may have. We are ready at all times to do whatever we can to help you get the most from your wire rope.

* * *

VICTIMS OF CORROSION!

These ropes never had a chance to live a full and useful life. Left unprotected against the elements, they were attacked and needlessly destroyed by the ever present wire rope saboteur: corrosion.

A very good example of Alkaline Corrosion. Notice how outside wires are partially eaten away—a rope unfit and unsafe. Crown wires have broken up. The other side of the rope next to the sheave has few broken wires . . . but if flexed in the opposite direction they would also break.

This rope was exposed to acid fumes which caused the wires to become brittle. This reduced their fatigue resistance and resulted in the wires breaking while bending over sheaves.

Macwhyte Company Manufactures:
MACWHYTE PREformed and Internally Lubricated Wire Rope
Monarch WHYTE STRAND Wire Rope
MACWHYTE Special Traction Elevator Cable
MACWHYTE Braided Wire Rope Slings
MACWHYTE Aircraft Cables and Tie Rods

NO. 818-C

MACWHYTE WIRE ROPE
Made by MACWHYTE COMPANY, Kenosha, Wis.
NEW YORK · PITTSBURGH · CHICAGO · FT. WORTH
PORTLAND · SEATTLE · SAN FRANCISCO
DISTRIBUTORS THROUGHOUT THE U. S. A.

The Petroleum Engineer, published monthly, August through June, semi-monthly in July, by The Petroleum Engineer Publishing Company, seventh floor Allen Building, Dallas, Texas. Subscription price, $2.00 per year, $3.00 for 2 years, 25c a copy. Entered as second-class mail matter May 1, 1932, at the post office at Dallas, Texas, under the Act of March 3, 1879.

May, 1942

THE Petroleum Engineer

VOL. XIII No. 8

THE PETROLEUM ENGINEER PUBLISHING CO. . . . Phone: Central-4571 . . . Seventh Floor Allen Building . . . DALLAS, TEXAS

Clarence Morris, President, 1929-40

A Magazine of Methods for Operating Men

EXECUTIVE

W. L. LOVE
President

W. T. BRYAN
General Manager and Treasurer

EDITORIAL

K. C. SCLATER
Vice-President and Editor

FRANK H. LOVE
Managing Editor

C. C. PRYOR
Assistant Editor

WALLACE A. SAWDON
Pacific Coast and Foreign Editor
2062 Paramount Drive
Los Angeles, California
Telephone: HIlside 1695

ADVERTISING

T. J. CROWLEY
Vice-Pres. and Advertising Mgr.

NEW YORK, N. Y.

ROGER MOTHERAL
7545 Kessel Street
Forest Hills, Long Island, N. Y.
Telephone: BOulevard 8-2959

CHICAGO, ILL.

E. V. PERKINS
330 South Wells Street
Telephone: HARrison 1843

LOS ANGELES, CALIF.

R. C. WIPPERMAN
518 North Sweetzer
Telephone: Webster 9617

CIRCULATION

C. R. BARRETT
Circulation Manager

C O N T E N T S

DRILLING AND PRODUCTION Page

Ample Availability of U. S. Oil Was No Accident ... 27
By PRENTISS T. MOORE
So, You Want to be a Petroleum Engineer? (Part 5) ... 31
By LESTER C. UREN
Portable Drilling and Servicing Units and Steel Conservation ... 42
By JAMES MOON
Locating Cased-off Productive Zones ... 55
By WALLACE A. SAWDON
Packer Tester Reduces Workover Time and Labor ... 60
Engineering Study Determines Advisability of Pressure-Maintenance Installation ... 62
By J. DAVISS COLLETT, JR.
Chemical Reconditioning of Old Wells ... 156
By J. H. ADKISON

SPECIAL REFINING SECTION

What Can Be Done About Sulphur in the Refinery? ... 72
By A. W. TRUSTY
Petroleum Plastics—The Acrylic Resins ... 80
By C. C. PRYOR
Technique of Precision Control in Refining Processes ... 86
By R. B. WEREY
Synthesis of Known Hydrocarbons in Petroleum ... 96
By W. L. FAITH
Reclaiming Used Refinery Equipment ... 107
By ARTHUR P. SCHULZE
Butane As a Source of Motor Fuel Volatility ... 116
By JAMES W. VAIDEN *and* JUSTUS O'REILLY
Refinery Practice for the Operating Man (Vocational Class Proceedings in Refinery Engineering) ... 123
Synthetic Rubbers to Meet Requirements of Natural Rubber in Industry ... 127
By C. C. PRYOR
Substitute Metals and Alloys for Refinery Uses ... 130
By B. B. MORTON
Economics of Water Conditioning for Scale and Corrosion Control ... 135
By R. C. ROHRDANZ
Changing Concepts of Petroleum Lubricants ... 140
By J. W. POOLE

OIL AND GAS TRANSPORTATION

Recent Developments in Cathodic Protection of Bare Pipe Lines ... 35
By G. R. OLSON
Plantation Pipe Line Pumping Stations Feature Automatic Control ... 147
Pipe Line Across River Hung Beneath Highway Bridge ... 162

NATURAL GASOLINE MANUFACTURE

Compressor-Absorption Type Gasoline Plant Produces Four Products ... 149
By FRANK H. LOVE

GENERAL

Maintaining Explosion-Proof Electrical Equipment ... 105
By PHELAN McSHANE
Statement on Revocation of P-83 ... 154
Statement on Additives (Recommendation 40) ... 154
Priorities for Foreign Operators ... 154
Asks Formulation of Oil-Field Development Program ... 154

ENGINEERING NEWS OF INTEREST

Proposed Revision of A.S.M.E.Code for Unfired Pressure Vessels ... 120
Review of Heaving Shale Problem in Gulf Coast Region ... 203
Oil Reservoir Behavior Based on Pressure-Production Data ... 211

PICTORIAL SECTION ... 49

REGULAR FEATURES

The Course of Oil ... 14
Highlights in Oildom ... 16
Major Refining Activities ... 18
Major Oil Field Activities ... 20
Petroleum Statistics and Field Activities ... 22
Major Pipe Line Activities ... 24
From Washington ... 154
Running Tour With Men in the Industry ... 164 and 166
Laugh With Barney ... 168
The Petroleum Engineer's Continuous Tables (Installment No. 59) ... 171
Machinery and Equipment ... 187, 188, 189, 190, 191, 192, and 193
Book Reviews ... 202
Trade Literature ... 214 and 215
Meetings ... 217

MEMBER A. B. C.—A. B. P. (The articles in *The Petroleum Engineer* are indexed in the *Industrial Arts Index*, New York, N.

Copyright 1942, by The Petroleum Engineer Publishing Company

Your shoes and *Ours*

You must have steel to do your part for Victory.

To take care of your needs, our plants are running day and night at capacity. Our men and women are AT WORK. We are busy producing our share of steel that America must have.

Is there enough steel for Victory? We say--Yes. We believe the nation's present difficulties with this critical material will be solved by cooperation between all users and producers, as partners for Victory.

When we at Youngstown look at your needs for steel, we try to put ourselves into your shoes; when you view the producer's problems, won't you try our shoes?

THE YOUNGSTOWN SHEET AND TUBE COMPANY
YOUNGSTOWN, OHIO

25-32E

The Course of Oil

by K. C. SCLATER

ACCELERATING WAR EFFORT

Presaging drastic changes that may be in store is the announcement that work on new plants not expected to be completed before midyear, 1943, may be suspended in order that steel and other critical materials can be put to more immediate use in the manufacture of essential war materials. Furthermore, greater effort will be concentrated on increasing the production of existing plants and speeding up the production of war goods in general.

This is a decided change in WPB policy, the real significance of which cannot yet be appraised. For one thing, it may point to a supreme effort to intensify the production of war materials in order that a maximum of highly essential fighting equipment will be available at decisive battlefronts during the remaining months of this year.

MATERIALS SCARCITY

At the Annual Meeting in Tulsa of the Natural Gasoline Association of America, natural gasoline manufacturers were warned that an increasing scarcity of materials of every description is in prospect. Officials were cautioned to survey thoroughly their existing inventories and operations to determine what materials are in the critical category so far as their own operations are concerned. Unless this is done, serious delays and disruptions in operations are inevitable. When these critical materials are known, only the minimum of essential parts need be carried to meet emergencies and to keep equipment in good repair.

This is sound advice that applies to all branches of the industry. The need for even greater conservation of materials will be felt severely during the next few months. Not only that, the number of materials on the critical list is daily becoming greater. All this calls for the utmost care and use in the husbanding of materials.

TRANSPORTATION PROBLEMS

The Petroleum Economics Committee of PIWC has just completed a study of problems connected with transportation facilities to the East Coast.

It appears that there is an absolute minimum need for tankers that must be given adequate protection to carry 250,000 bbl. of oil daily. This represents only about one-sixth of the quantities normally moved by tanker to the East Coast.

To care for these situations that involve hardships but do not represent needs fully essential for the war effort will require a movement of 160,000 bbl. a day additional by tankers, or a total of 410,000 bbl. daily, at least until the proposed emergency pipe lines are built.

When studied in detail the analysis of the steel and capital requirements of various methods of transportation bring out many interesting points, among the most important of which are, that even allowing for substantial inefficiency in operation under war conditions, tankers require less steel than any other method of transportation. Large product pipe lines and barges come next, large crude lines next, and tanker cars about the last. On overall capital requirements, which are a rough measure of the equipment needed, pipe lines show up a little better than ships or barges.

These are interesting deductions. They suggest that pipe-line transportation for war needs and from the steel conservation standpoint are highly desirable, especially when the possibility of losses by tanker sinkings are considered. Had these factors been recognized and properly appraised a year ago, they might have forestalled the present transportation bottleneck, which now is impeding operations throughout the industry, even down to the smallest well.

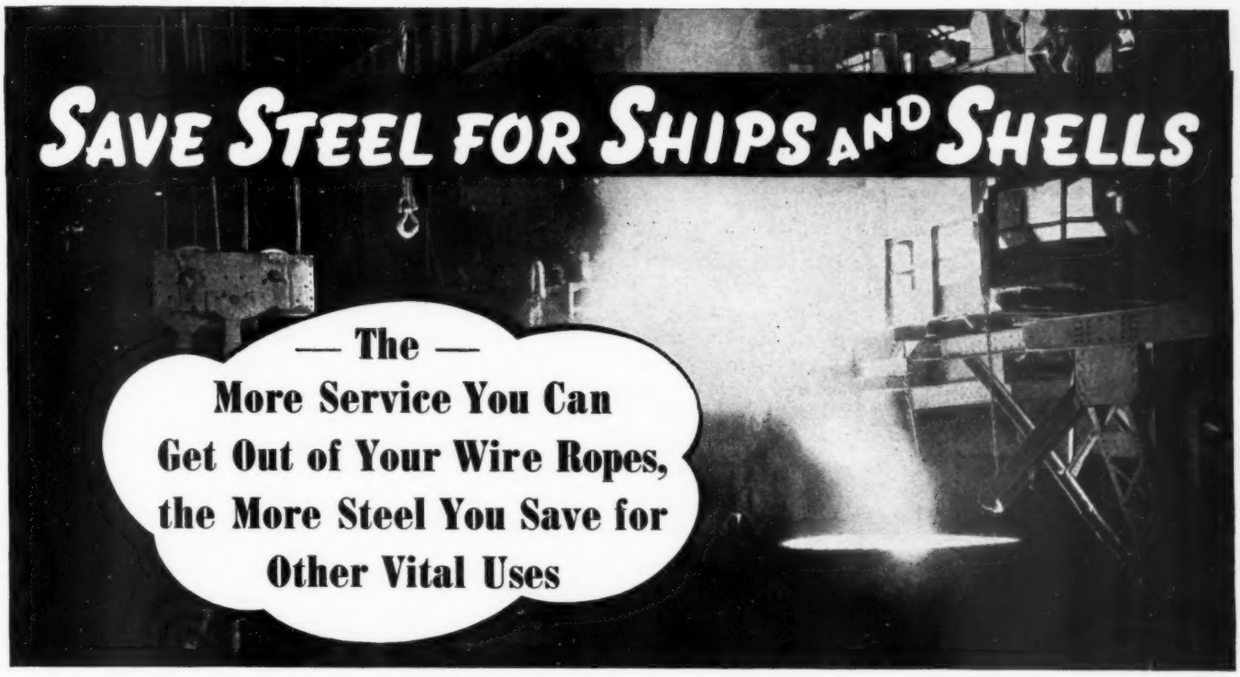
P-98 EXTENDED

It has just been announced by the WPB that P-98, the order under which applications are made for materials used in the production of oil and gas, will continue in effect until July 1. What will happen after that date, no one knows. It has been hinted that a new allocation system by industries may be introduced. Under such a system the petroleum industry would be allotted its quota of materials on a ninety-day basis. Materials would be parceled out among operators according to some plan that would take into consideration the specific use of the material and what it would contribute to the war effort; this, in fact, would probably be the sole governing consideration.

NATURAL GASOLINE

What further restrictions are in store during the coming months are likely to have far-reaching effects on some branches of industry, the petroleum industry not excepted. Natural gasoline manufacturers were warned that additional installations for the manufacture of 100-octane gasoline will probably not be authorized, at least in the very near future, according to D. E. Buchanan, Associate Director of the Natural Gas-Natural Gasoline Division of the OPC. They were cautioned to look ahead to see what they could contribute in the way of raw materials for the manufacture of synthetic rubber and toluol. A thorough study should be made of the feasibility of producing gasoline of 100-octane and even higher — don't stop at 100-octane, Buchanan urged. He also stated that tests have shown appreciable toluol content in certain natural gasolines and that it is quite possible some of them may prove more desirable for toluol extraction than crude oils currently being processed.

On the whole, the operations of natural gasoline manufacturers are likely to undergo a profound change if they are to be adjusted to the rapidly-changing requirements brought on by the war.


SAVE STEEL FOR SHIPS AND SHELLS
— The —
More Service You Can
Get Out of Your Wire Ropes,
the More Steel You Save for
Other Vital Uses

In the Interest of Our Present National Emergency...

WE OFFER THE FOLLOWING SUGGESTIONS:

1. Keep your wire rope using equipment in good condition. Sheaves should be of proper size, design, material—and free from corrugations. Keep all sheaves and idlers properly lubricated and in line. Avoid excessive fleet angles.

2. Keep your wire ropes thoroughly and correctly lubricated.

3. Avoid kinks and sudden jerks... also, avoid cross-winding on drums, and reverse bends if possible.

4. Make sure your wire ropes operate with an adequate factor of safety. If there is not a proper ratio between the strength of the rope and the maximum load to be handled, the rope may be overstressed—a condition no rope can long survive.

5. Use wire rope of the correct size, construction, type and grade for your particular conditions.

The foregoing suggestions are necessarily brief. We shall be glad to give further particulars to any one interested.

A. LESCHEN & SONS ROPE CO.

WIRE ROPE MAKERS — ESTABLISHED 1857

5909 KENNERLY AVENUE — ST. LOUIS, MISSOURI, U. S. A.

NEW YORK . . . 90 West Street
CHICAGO . . 810 W. Washington Blvd.
DENVER . . . 1554 Wazee Street

HERCULES "RED STRAND" WIRE ROPE

SAN FRANCISCO . . 520 Fourth Street
PORTLAND . . 914 N. W. 14th Avenue
SEATTLE . . 3410 First Avenue South

Highlights IN OILDOM

Bottom-Hole Pressure Increases in East Texas

Many wells in the East Texas field have begun flowing again due to sharp increases in bottom-hole pressure, field engineers reveal.

Tests have indicated, unofficially, that pressure losses of the last ten months already have been restored by the sharp reduction in production. If the present proration schedule continues two or three months, engineers say, the field may regain pressure losses of the last two or three years.

The gain in pressure is lifting oil in centrally located wells that were placed on pump last summer. The effect has not been felt strongly in the eastern part of the field, which is farthest from the water drive and least subject to pressure changes.

Field pressure until 1941 declined an average of about 30 lb. a year. The decreases accelerated last autumn and continued at a rapid pace until halted in March.

Pressure increased 19.25 lb. in March, the Texas Railroad Commission reported. The April increase was estimated, unofficially, at between 25 and 30 lb.

Europe's Oil Consumption Lower Than Estimated

Hitler's Europe must be using much less petroleum than has been hitherto suspected, recent calculations by oil experts reveal, but wide speculation still continues about the extent of his oil resources and how long they can last, says a report of the American Petroleum Institute.

The maximum production of crude oil and all substitutes for petroleum in all Axis Europe in 1941 was not more than 130,000,000 bbl. or about as much as the United States alone produces in a month, according to compilations by Dr. Gustav Egloff reported at the recent meeting of the American Chemical Society. Other sources indicate that production of petroleum and synthetic oils from coal did not exceed 100,000,000 bbl. last year.

The rate of consumption, therefore, cannot be anywhere near the immense quantities suggested by many experts. If consumption were at the rate of 21,500,000 bbl. a month, with 17,000,000 bbl. required for the Russian front, as has been suggested, the total 1941 demand would have been 255,000,000 bbl., or 125,000,000 bbl. more than the maximum production. It is incredible that Hitler's reserve stocks could withstand such a drain.

The London "Petroleum Press Service" in its April issue reports that even the widely-held estimates of 7,500,000 to 15,000,000 bbl. a month consumption on the Russian front must be far too high. If these estimates had any foundation in fact, this paper says, "the struggle would by now have ended in Nazi defeat." Although predictions have been made regularly since the war began that Germany was near the end of its oil reserves and would falter soon, that source states: "There would appear to be no evidence that the German military machine is as yet handicapped by any immediate or threatened shortage of oil for fighting purposes. The Germans would have been incapable of withstanding the furious Russian counteroffensive—still less of preparing for a renewed drive on a gigantic scale—if the strain on their oil resources had not remained within bearable limits."

Most oil experts have agreed that Germany's chief deficiencies are in high-grade lubricating oils, which are difficult of manufacture from synthetic oils. The Rumanian, Polish, and Czechoslovakian crude oils available also are known to be relatively poor sources of lubricants. A prominent war correspondent recently reported that these facts suggested that Germany's spring objective therefore would have to be Russia's Caucasus oil fields, for the crude oil from Baku makes high-quality lubricants, whereas the petroleum from Iraq and Iran is not nearly so suitable.

On the other hand, the "Petroleum Press Service" story indicates the possibility that Germany's chemists have been able to make great improvements in the synthetic-oil processes and are producing good quality lubricants from coal oils.

The actual facts, of course, despite all inferences and informed guesses, must remain unknown. It is obvious that the Nazis have nowhere nearly as much petroleum as could be used, and it is probable that their reserves are very low. Yet they evidently are preparing a massive offensive that would be impossible without the most careful attention to their oil position.

Oil-Industry Safety Record Improves

Petroleum-industry employees had 11 percent fewer accidents in the first part of 1942 than in the same period of 1941, and petroleum truck fleets showed a 23 percent decrease in traffic accident frequency in the last half of 1941, according to a recent report of the Petroleum Section of the National Safety Council.

Both records were established in the face of rising accident rates in most industries in the country. The improvement in oil-truck safety was greater than that recorded by the fleets of any other industry, and compared with an all-industry truck accident rate that increased 5 percent. Every department in the industry contributed to the 11 percent decrease, from wholesale marketing accidents, which dropped 5 percent, to the oil and gas pipe line accident rate, which decreased 20 percent.

Census of Contractors

The U. S. Census Bureau has issued its report on "Oil- and Gas-Field Services Performed by Contractors," the first extensive survey ever made of the contractors connected with the petroleum industry. This report shows the large variety of services performed by contractors. Based on the proportion of footage of all oil, gas, and dry wells drilled, 60 percent of the development work in the industry was performed by contractors. Some of these contractors have specialized in exploration and well surveying work; others in building rigs, drilling wells, shooting wells, perforating well casing, acidizing, etc. The report shows the number and footage of oil, gas, and dry wells drilled by contractors and the cost of drilling per foot.

Bentonite Deposit Found

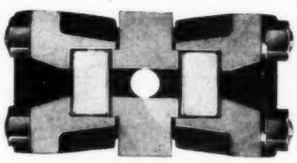
A 40-acre deposit of bentonite—a clay used extensively in the refining of petroleum and for rotary drilling muds—has been located in Jasper County, Texas, near the old townsite of Browndell, and has been mapped by the University of Texas Bureau of Economic Geology, with aid of WPA field crews, Dr. E. H. Sellards, bureau director, has announced.

The deposit is approximately 20 ft. thick and is "very conveniently located for shipment to market," Doctor Sellards said. "The latter feature," he added, "will undoubtedly influence the development of the material to a great extent, as nearness to rail transportation is one of the chief factors for successful exploitation of such resources."

FOR EVERY GAGE REQUIREMENT

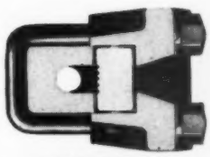
Whatever your liquid level gage requirements, there is a Penberthy Gage that will meet your needs. These gages are suitable for the various pressure and temperature conditions of the oil industry. All Penberthy Gages conform with A.P.I.-A.S.M.E. requirements.

Write for a copy of Catalog 34-A.



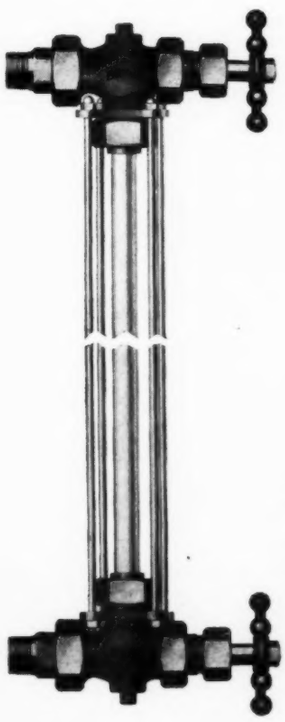
PENBERTHY
Transparent
DROP FORGED STEEL LIQUID LEVEL GAGES

Used to observe color and density of liquids under high pressures, and/or temperatures. Construction is exceptionally rugged . . . similar to Reflex types.



PENBERTHY
Reflex
DROP FORGED STEEL LIQUID LEVEL GAGES

Liquid shows black—empty space shows white. Preferred wherever liquid level must be easily and positively visible . . . and when liquids are under high pressure or at high temperature.



PENBERTHY
DROP FORGED STEEL LIQUID LEVEL GAGES

Made of Chromium-molybdenum alloy temperature-resisting steel, extra heavy throughout. Stainless steel trimmed. Tubular glass type gages also available in various other metals suitable for practically all conditions.

PENBERTHY *Reflex*
WATER GAGE SET

Water shows black—steam shows white. U-Bolt construction is strongest and simplest to service. Glass replaced by simply removing nuts on face of gage . . . unnecessary to work between gage and boiler.

PENBERTHY PRODUCTS

PENBERTHY INJECTOR CO.

DETROIT, MICHIGAN ● **Canadian Plant: Windsor, Ontario**

MAJOR *Refining* ACTIVITIES

Percent Refining Capacity Operated

Western Division, 72.9 Percent **Central Division, 88.5 Percent** **Eastern Division, 65.0 Percent**

THE general committee of the Office of Petroleum Coördinator in District 3 has designed a plan to maintain Gulf Coast refinery operations at an efficient level in keeping with transportation conditions and demand for the products.

The committee is most concerned with the maximum production of war materials such as 100-octane gasoline, toluene, and butadiene. Charles F. Roeser, chairman of District 3 general committees announced the details of the plan, which will be submitted to the various functional committees. After final approval in the district Petroleum Coördinator Ickes will be petitioned to place the program in effect by a directive recommendation.

Six points of the plan are as follows: The refining committee will determine the production of the refineries to meet market demands in the district. This production will be broken down between refineries producing war products and those not producing them and between seaboard and inland refineries of District 3. The director of transportation of the OPC will then determine the transportation available for moving the products. The director of petroleum supply of the OPC will determine the quantity of oil products that are not included in the first two sections for shipment outside continental United States. The total outlet available for refined products will be determined by the refining committee for the district. Determination of the petroleum war products at stated or maximum rates if necessary will be made by the director of refining of OPC. A plan for operation of refineries to produce the products with minimum refinery runs of crude oil is to be devised by the refining committee for each calendar month, and will distribute equitably among the refineries of the district the remainder of the total outlet available after deducting the minimum refinery runs of crude in such manner as to give refineries within the district as nearly as possible the same percentage of operations to be based on the average runs of crude oil for the last six months of 1941.

The W. R. Davis cycling plant in the Alice field, Jim Wells County, Texas, has been purchased by H. J. Mosser of Alice, Texas. Reported cash consideration involved in the transaction was $550,000. With a capacity of nearly 100,000,000 cu. ft. per day, the plant receives gas for processing from wells in the Ben Bolt area.

M. W. Kellogg Company has been awarded a contract by the Standard Oil Company of New Jersey for construction of additional facilities for gasoline processing at the latter's Baltimore, Maryland, refinery, which will cost approximately $2,000,000. The refinery has a present capacity of 37,000 bbl. per day.

Attorney General Gerald Mann, Austin, Texas, has stated that the coöperative association, Neches Butane Products Company, a Delaware corporation formed by Gulf Oil Corporation, Atlantic Refining Company, Pure Oil Company, Socony-Vacuum Oil Company, Inc., and The Texas Company, is permissible under the Texas anti-trust laws. The federal government requested organization of the corporation. Defense Plants Corporation, subsidiary of Reconstruction Finance Corporation, will finance construction of the butadiene plant, which will operate on butanes and butenes supplied by Gulf Coast refineries of the involved companies. The Rubber Reserve Corporation, also a subsidiary of the Reconstruction Finance Corporation, reportedly will purchase the principal product from the plant to be operated by the Neches Butane Products Company.

The Neches Butane Products Company plant is one of several approved by the Office of Petroleum Coördinator, War Production Board, and the Reconstruction Finance Corporation as part of the government's plan to produce 700,000 tons of synthetic rubber per year.

Officials of the new company are W. H. Hoffman, president; H. P. Arbuckle, secretary, and F. F. Bosburn, Texas agent.

The plant will cost approximately $50,000,000 and produce nearly 50,000 tons of synthetic rubber per year, but will not begin production for about 18 months.

Suspension of operation for the West Dallas, Texas, refinery of The Texas Company due to lack of transportation for southwestern petroleum products has been announced. This refinery has a rated crude-oil capacity of 15,000 bbl. per day with a 14,000 bbl. cracking unit. It has been used to supply the Fort Worth-Dallas area. One of the largest refineries on the Gulf Coast owned by The Texas Company at Port Arthur, will now supply the area. Previously the company had shutdown the Galena Park refinery near Houston, Texas, which plant has a crude oil capacity of 25,000 bbl. per day and a 2500-bbl. cracking unit.

According to J. S. Leach, the shutdowns are caused by inability to transport petroleum products to the East Coast. Production of the Port Arthur plant is normally moved by tanker to the East Coast, but will now supply areas served by the closed plants.

Petroleos Mexicanos, the Mexican government oil agency, is planning construction of a new refinery near Tampico, Mexico, employing American engineers and materials. The refinery will contain a unit for production of aviation gasoline. It is expected that the proposed plant will cost about $7,500,000.

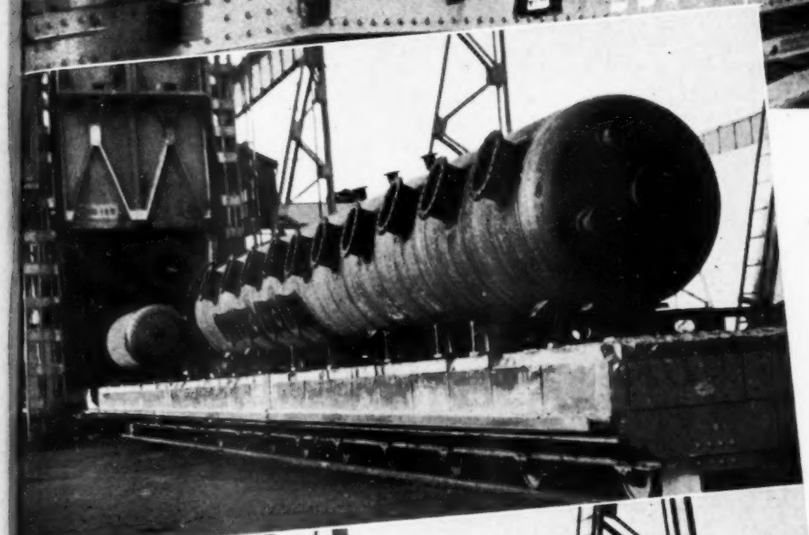
Crude Runs to Stills, Gasoline, Gas and Fuel Oil Stocks
Week Ended May 2, 1942
A.P.I. Figures

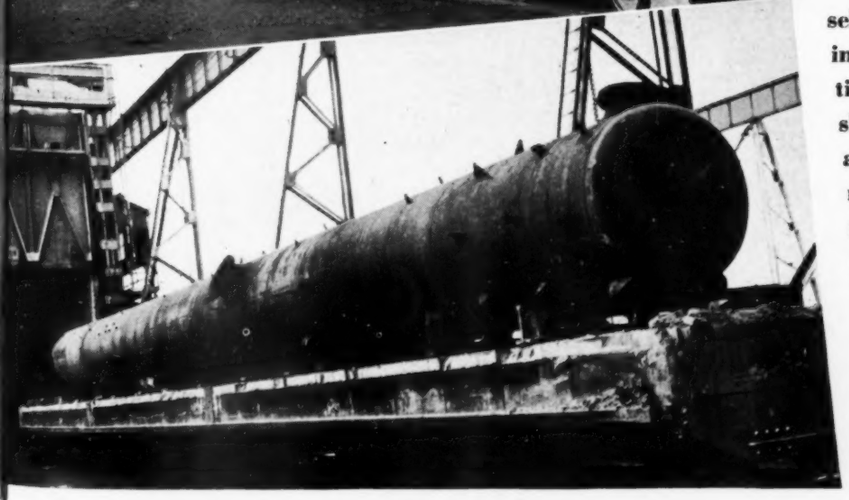
(Figures in thousands of bbl. of 42 gal. each)

DISTRICT	Percent Potential Capacity Reporting	Daily Avg. Crude Runs to Stills	Percent Operated of Total Capacity Reporting	Total Motor Fuel Stocks	Total Gas and Fuel Oil Stocks
*Combined: East Coast, Texas Gulf, Louisiana Gulf, North Louisiana-Arkansas, and Inland Texas	89.7	1,549	65.0	45,807	29,637
Appalachian	84.5	160	92.0	3,995	1,010
Ind., Ill., Ky.	84.9	703	89.7	21,842	5,941
Okla., Kans., Mo.	81.1	355	84.9	10,072	2,549
Rocky Mountain	50.7	83	60.1	2,481	876
California	90.9	591	75.1	17,179	69,564
TOTAL U. S.— B. OF M. BASIS MAY 2, 1942	86.9	3,441	73.5	101,376	109,677
TOTAL U. S.— B. OF M. BASIS APRIL 25, 1942	86.9	3,506	74.9	102,897	120,347
U. S. B. OF MINES BASIS MAY 3, 1941	.....	3,772	.....	95,823	123,910

*At the request of the Office of the Petroleum Coordinator.

WELDED STEEL PRESSURE VESSELS





For the NATION'S REFINERIES

WELDED steel pressure vessels and refinery towers are playing an important role in the war effort. For, without modern equipment of the type shown here, it would be impossible for the nation's refineries to sustain today's vital production of high octane fuels, lubricants, and the numerous other essential petroleum products.

Production capacity of welded steel pressure vessels and refinery towers of all types has of course been increased tremendously, but the design and fabrication of this class of work is by no means new to our shops. Plant facilities for handling difficult welding and fabrication, as well as radiographing and stress relieving, are complete in every detail. All work must pass the strictest inspection during each step of fabrication, which assures the expected results when installed at the refinery.

• **ABOVE:** *7 ft. diam. by 85½ ft. bubble tower, x-rayed and stress-relieved for an Oklahoma refinery.* **LEFT, CENTER:** *One of three 6 ft. 4 in. diam. by 45 ft. stress-relieved vessels built for West Indies service.* **BOTTOM, LEFT:** *5½ ft. diam. by 71½ ft. absorber tower.*

CHICAGO BRIDGE & IRON COMPANY

BIRMINGHAM • CHICAGO • CLEVELAND • DETROIT • HOUSTON • NEW YORK
PHILADELPHIA • SAN FRANCISCO • TULSA • WASHINGTON

MAJOR *Oil Field* ACTIVITIES

THE Alma Oil Company apparently has opened a new oil pool of considerable size with its Deroin No. 1, a wildcat test in northeastern Pawnee County, Oklahoma, in SW NW NW of 25-23n-3e. The test, situated between the Watchorn pool on the west and the Masham pool on the east, was not considered an extremely important test and received little notice,

Simpson dolomite was topped at 3810 ft. and a survey run at 3859 ft. indicated oil and gas prospects. Drilling, in charge of Joe Trigg, contractor, continued to 3880 ft. and found the Wilcox sand. This formation showed oil to 3891 ft., large gas volume being encountered at that depth. One hundred and eight bbl. of oil flowed from the well during the first hour; 107 bbl. the second hour; 113 the third hour; 108 the fourth; 107 the fifth, and 108 the seventh. Gas volume through 7-in. casing was estimated at 15,000,000 cu. ft.

The wildcat is located on a structural high that geologists say extends across the Arkansas River and into the extreme part of southwestern Osage County.

◆

The Phillips Petroleum Company has announced the completion of a well in West Texas as the opener of a new Ordovician pool. The well, University No. 1 in section 30-10-U, Andrews County, produced by natural flow through 2-in. tubing 380 bbl. of 44.3-gravity oil on a three-hour test. The gas flow was estimated at 2,500,000 cu. ft. per day.

The Ellenburger dolomite was topped at 7740 ft. Total depth of the well is 7855 ft., being completed in the dolomite. Fifty-eight of the 115 ft. of dolomite revealed good porosity and saturation. Casing was cemented at 7805 ft.

The Phil-Han Oil Company and Adair and Morton, Anderson No. 1 has extended the Henne pool in McPherson County, Kansas, a quarter mile northwest of present production. The well pumped 774 bbl. of oil through 2½-in. tubing in 24 hours on an official test. Production began after chat was acidized at 2645 ft. The top of the producing zone was found at 2634 ft.

Stafford County, Kansas, has a new extension to the Drach pool, one-half mile to the east. Stanolind Oil and Gas Company Harme No. 1, CN½ NE NW of 18-22-12w, was given a state allowable of 74 bbl. per day from the Arbuckle at 3671 ft. after acidizing. The top of the Arbuckle was found at 3666 ft. The well swabbed 20 and 23 bbl. of oil on a two-hour test.

◆

A new oil field has been opened in the Hays area, Calcasieu Parish, Louisiana, by Gulf Oil Corporation's Calcasieu National Bank No. 2. This well made 61 bbl of 46-gravity oil through a 3/16-in. choke during an initial production test. Approximately 4,000,000 cu. ft. of gas accompanied the oil flow.

◆

A stratigraphic test by the Carter Oil Company on their Abernathy No. 1, SW SW section 29-12s-5e, Chickasaw County, Mississippi, a wildcat well, logged three oil showings in the Mississippian zone at 2410-27 ft., 2705-08 ft., and 3108-31 ft. Casing has been run. Total depth of the well is 3494 ft. Location of the well is 30 miles west of the old Armory gas field, now depleted.

AVERAGE CRUDE OIL PRICES

California	
Kettleman Hills	$1.23-1.29
Playa Del Rey	.80- .87
Coalinga	.73-1.13
Wilmington	.68-1.24
Montana	1.00-1.15
Wyoming	.45-1.15
Colorado	.96-1.20
New Mexico	.70-1.15
Texas	
North Central	.97-1.21
Panhandle	.70-1.12
West Texas	.80-1.27
Gulf Coast	.93-1.48
Darst Creek	1.14
East Texas	.80-1.27
Talco	.79
Kansas	.93-1.25
Oklahoma	.75-1.25
Arkansas	.94-1.36
Louisiana	
Rodessa	$ .88-1.20
Gulf Coast	.93-1.36
North Louisiana	.98-1.30
Illinois	1.22-1.37
Kentucky	1.32-1.43
Indiana	.85-1.25
Ohio	
Lima	1.17
Michigan	1.24-1.44
Pennsylvania	
Bradford	3.00
Southwest	2.65
Eureka	2.59
Buckeye	2.55
Corning	1.31

DAILY AVERAGE CRUDE OIL PRODUCTION

Data Supplied by A.P.I.

(Figures in bbl. of 42 gal. each)

	[1]O.P.C. Recommendations for April	Week Ended May 2, 1942	Week Ended March 28, 1942	Week Ended May 3, 1941
Oklahoma	436,900	[2]404,650	387,350	408,650
Kansas	253,400	[2]255,300	238,900	209,100
Nebraska	5,000	[2] 3,900	4,150	4,200
Panhandle Texas	.....	78,500	89,200	76,850
North Texas	.....	161,800	148,800	125,800
West Texas	.....	140,150	233,200	210,250
East Central Texas	.....	73,900	90,000	74,950
East Texas	.....	146,400	368,200	304,000
Southwest Texas	.....	114,500	195,850	175,100
Coastal Texas	.....	181,250	284,900	232,800
TOTAL TEXAS	1,134,000	896,500	1,410,150	1,199,750
North Louisiana	.....	81,850	81,100	72,100
Coastal Louisiana	.....	232,500	253,800	235,450
TOTAL LA.	313,000	314,350	334,900	307,550
Arkansas	74,000	73,600	76,750	72,350
Mississippi	49,800	[2] 91,250	94,250	28,450
Illinois	354,400	295,150	317,550	322,900
Indiana	18,200	[2] 20,850	19,350	21,800
Eastern (not incl. Ill. and Ind.)	102,600	103,200	96,800	93,250
Michigan	60,200	63,200	45,900	38,000
Wyoming	88,900	90,750	91,000	73,600
Montana	23,700	21,600	24,400	19,100
Colorado	6,900	5,250	5,600	3,800
New Mexico	86,000	73,650	92,800	108,800
TOTAL EAST OF CALIF.	3,007,000	2,713,200	3,286,850	2,911,300
California	659,800	621,800	583,000	595,800
TOTAL U. S.	3,666,800	3,335,000	3,819,850	3,507,100

[1]Beginning with April the O.P.C. recommendations represent the production of all petroleum liquids, including crude oil, condensate and natural gas derivatives recovered from oil, condensate and gas fields. Formerly the recommended rates were for crude oil only. State allowables are also calculated on the same basis beginning with April. It may be that certain wells will be found incapable of producing the allowables granted. Actual state production may, for this reason, prove to be less than the allowables. The Bureau of Mines reported the daily average production of natural gasoline in January, 1942, in barrels as follows: Oklahoma, 29,000; Kansas, 6,000; Texas, 114,000; Louisiana, 21,000; Arkansas, 2,000; California, 43,000; other states, including New Mexico, 26,000.

[2]Oklahoma, Kansas, Nebraska, Mississippi, Indiana figures are for week ended 7 a. m., April 29th.

"KEEP 'EM PRODUCING—

that's our job!"

"KEEP 'EM PRODUCING . . . We must maintain production—*and do it with less manpower and less equipment.*

"That's the man-sized problem to be solved by oil producers as *their* part in the Victory program.

"Can it be done? Yes—and Dowell is helping do it. Ten years of experience in oil and gas well servicing give the 'know-how'. Dowell Services are daily adding many extra barrels of oil for the use of our mechanized armed forces—*and conserving manpower and materials for the producers* as well.

"It's a story you'll want to know—completely. Let us give you all the facts about these timely answers to your problems and America's vital need."

DOWELL INCORPORATED

Executive Office: MIDLAND, MICHIGAN—*General Office:* KENNEDY BUILDING, TULSA, OKLAHOMA

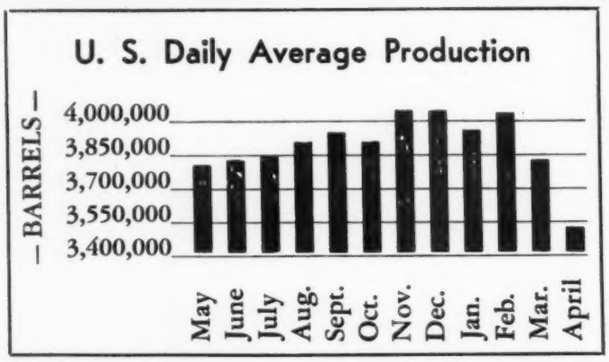
Subsidiary of The Dow Chemical Company

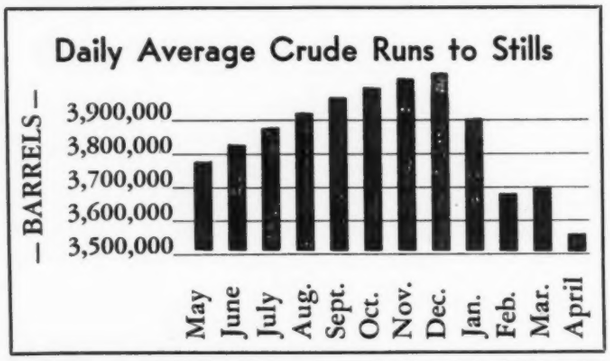
Look to

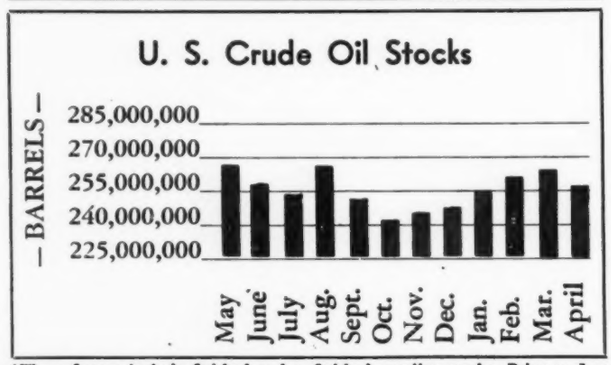
DOWELL

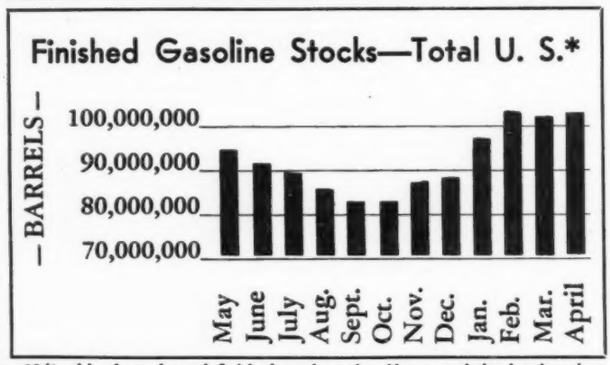
FOR OIL AND GAS WELL CHEMICAL SERVICE

PETROLEUM *Statistics* AND FIELD *Operations*









*These figures include finished and unfinished gasoline stocks. Prior to January, 1941, this chart showed finished stocks only. Above statistics by American Petroleum Institute.

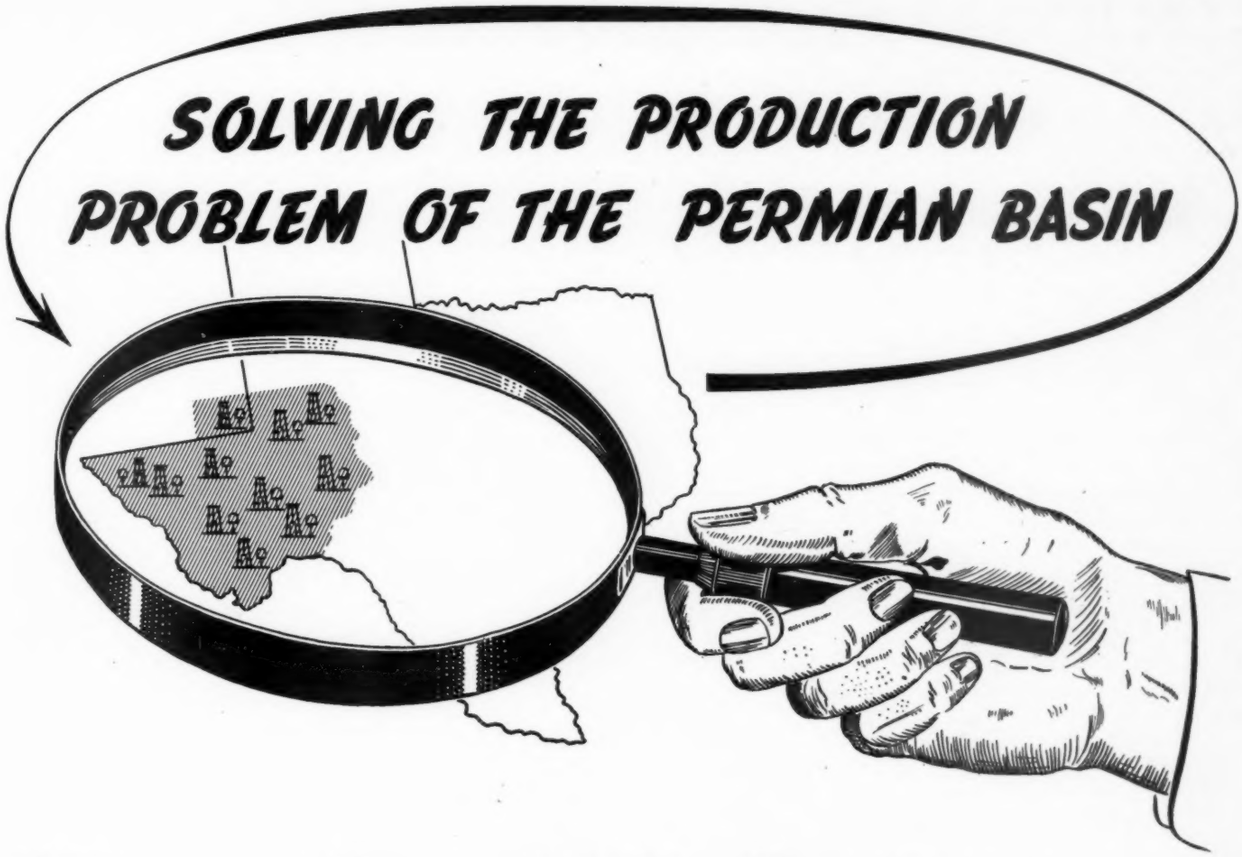
Summarized Operations in Active Fields for April, 1942

	Completions	Producers	Rigs	Drilling Wells	Depth of Production	No. Casing Strings	Gravity of Oil	Type of Tool Used
TEXAS								
East Texas	44	26	5	41	3500-3700	2	40	Rotary
Gaines County	6	5	2	6	4400-5584	2	22-35	Rotary
Hockley County	31	20	6	24	4800-6850	2	20-30	Rotary
Ector County	18	14	5	16	3675-4377	2 or 3	32-36	Rotary
Panhandle	53	45	8	51	1700-3900	2	40	Rot.-Cab.
Nueces County	9	6	3	8	3922-5878	2 or 3	21-54	Rotary
K. M. A. Field	8	5	3	12	3730-3935	2	42-43	Rot.-Cab.
Hawkins Field	14	9	4	9	4495-4912	2	19-29	Rotary
OKLAHOMA								
Okfuskee County	6	5	7	3	2150-4125	2 or 3	38	Rotary
KANSAS								
Russell County	9	7	5	4	2926-3435	2 and 5	32-37	Rot.-Cab.
Rice County	8	4	6	3	3222-4085	2 and 5	42-48	Rot.-Cab.
Barton County	5	3	6	6	3290-3518	2	39-42	Rot.-Cab.
ILLINOIS								
Central Illinois	125	93	96	107	1425-4100	2	36-38	Rot.-Cab.
NEW MEXICO								
Lea County	20	18	5	8	3150-4030	2	30-34	Rot.-Cab.
CALIFORNIA								
Kern County	16	15	9	9	1840-11,450	3 or 4	14-30	Rotary
Wilmington	8	5	3	5	3500-4000	2 and 3	18-20	Rotary

Field Activities by States for April, 1942

STATE	Completions		Producers		Locations		Rigs		Drilling Wells		Production, 1941 (In Barrels)
	April	March	April	March	April	March	April	March	April	March	
Arkansas	24	18	22	14	17	3	8	3	8	3	29,263,000
California	72	50	64	36	49	50	37	40	18	21	230,271,000
Colorado	....	....	....	....	....	....	....	....	....	....	1,792,000
Illinois	125	98	93	63	66	79	96	98	107	104	131,272,000
Indiana	47	25	32	13	30	26	10	8	19	16	6,998,000
Kansas	88	72	70	43	75	70	14	14	94	88	82,733,000
Kentucky	....	....	....	....	....	....	....	....	....	....	4,790,000
Louisiana	101	84	86	53	39	46	25	22	37	41	116,038,000
Michigan	41	28	33	15	41	34	15	11	28	25	16,312,000
Mississippi	22	9	16	4	....	....	....	....	....	....	15,528,000
Montana	15	7	12	5	0	3	4	1	10	4	7,440,000
Nebraska	....	....	....	....	....	....	....	....	....	....	1,785,000
New Mexico	54	36	48	28	21	13	9	6	13	15	39,109,000
New York	96	88*	94	88*	....	....	....	....	....	....	5,180,000
Ohio	71	53	68	42	....	....	....	....	....	....	3,342,000
Oklahoma	130	94	118	57	92	81	21	15	76	73	154,817,000
Pennsylvania	264	248	240	243	....	....	....	....	....	....	16,700,000
Texas	762	435	514	311	636	495	463	308	443	310	501,745,000
West Virginia	67	48	53	41	37	40	20	16	29	25	3,418,000
Wyoming	9	6	5	4	5	3	4	2	3	1	29,952,000
Total	1988	1399	1568	1060	2676	943	726	544	885	726	1,398,485,000

*Includes water-intake and pressure wells.



Nixon Gas-Lift Systen

Look at the records of a number of leases in the Permian Basin that are producing with the Nixon Gas-Lift System.

Several hundred installations in this West Texas-New Mexico area are handling the heavy volumes of sand, formation gas, and low fluid levels with extreme economy and efficiency.

Operating costs are being held to an extreme low, so that despite low allowables and small returns, operators are able to show a profit.

Lease A
Number of Wells equipped with Nixon Gas-Lift 42
Average months of operation per well . . . . 17.9 months
Average cost of repair parts per well per day . . . $.048

Lease B
Number of Wells equipped with Nixon Gas-Lift 29
Average months of operation per well . . . . . 10.5 months
Average cost of repair parts per well per day . . $.0026

Lease C
Number of Wells equipped with Nixon Gas-Lift 37
Average months of operation per well . . . . . 11.2 months
Average cost of repair parts per well per day . . $.0058

Lease D
Number of Wells equipped with Nixon Gas-Lift 16
Average months of operation per well . . . . . 13 months
Average cost of repair parts per well per day . . . $.022

WILSON SUPPLY COMPANY

1412 MAURY STREET — **HOUSTON, TEXAS**

SALES OFFICES: Tulsa, Oklahoma; Dallas, Texas
LOS ANGELES: 1341 South Hope St., Phone Richmond 9121
TRINIDAD, B.W.I.: Neal Massey Eng. Corp.

BRANCH STORES: TEXAS—Gladewater, Barbers Hill, Bay City, Monahans, Alice, Victoria, Corpus Christi. LOUISIANA—Rodessa, Lake Charles, New Iberia, Harvey, Shreveport

MAJOR *Pipe Line* ACTIVITIES

A NEW 32-mile section of 12-in. pipe line between Heyworth and Wilmington, in southern Illinois, paralleling an existing section of line, will soon increase by about 15 percent the delivery of crude oil to Chicago, Illinois, refineries by The Texas-Empire Pipe Line Company, subsidiary of The Texas Company and the Cities Service Company.

Work has begun on the new section of line, which is expected to be completed in approximately 30 days, officials of the pipe line company report. Upon completion of the line, the system, which extends to the oil fields of the southwest, will include double lines into Chicago.

The line has been supplying The Texas Company plant at Lockport and the Cities Service plant at East Chicago.

Recommended plans have been completed for construction of a 1400-mile pipe line to alleviate the shortage of crude oil and gasoline on the Atlantic seaboard.

The final specifications for the all-important project to carry oil from the East Texas fields into the Illinois basin and Ohio River shipping points have been received in Washington, D. C.

The cost of construction of the line has been unofficially estimated at $25,000,000 to $30,000,000. The line will have a capacity of 300,000 bbl. per day. This flow is expected to step-up volume of oil shipments into the eastern area to more than 1,000,000 bbl. per 24 hours. With normal consumption in the east nearly 1,500,000 bbl. per day it is expected that with rationing the supply will be sufficient.

Pipe to be used in the line will be reconditioned pipe and rebuilt pumping equipment. No approval from the priorities administration of WPB-OPC is required to construct the line with used equipment. Priorities have been refused several times to Oil Coördinator Harold L. Ickes for the use of new steel pipe and equipment for a similar project.

Surveys by the industry have disclosed approximately 1400 miles of 10- and 12-in. pipe that can be taken up from little-used lines or salvaged for the new line. Most of this equipment is in the Texas and Gulf Coast areas. Some of the pipe lines to be taken up are only partially in use and some are idle.

This line will transport oil to Illinois and Ohio River shipping centers, from where it will be further transported by river barges, railroad tank cars, and loops on existing pipe lines to the eastern points. Overland shipping to the Atlantic Coast area is now approximately 700,000 bbl. per day.

Numerous government officials have approved the project, which would require about six months to construct. It is expected that the cost of the line will be borne by the oil companies and preliminary details of the project were worked out by the Petroleum Industry War Council.

Diversion of an increasing number of tank cars from the Mid-Continent and other areas for service into the Atlantic Coast area has been requested by the government. This is reportedly in line with the government's plan to depend entirely on overland shipments instead of coastwise tankers, which have been targets for submarines operating in Atlantic waters.

Construction is now beginning on at least 7 of 10 new pipe-line projects designed to relieve the eastern shortage of oil and gasoline, according to a report of the Petroleum Industry War Council.

Chairman W. Alton Jones states that all projects begun or to begin soon are contemplating the use of pipe and equipment taken from existing lines. Jones said the pipe line from East Texas to New York and Philadelphia is still "marking time," because it would require new pipe.

Among the major projects soon to begin, Alton reported, will be the reversing of a crude line between East Texas and Houston and extension of the line to a point near Paducah, Kentucky, on the Ohio River. This line is expected to move approximately 75,000 bbl. of crude oil daily to the river terminal from which it will be carried to eastern points by river barge and railroads.

Plans to extend both ends of the Plantation Pipe Line Corporation gasoline pipe line operating from Baton Rouge, Louisiana, to Greensboro, North Carolina, are also well under way. The plans are to extend the southern end of the line to Beaumont whereas the northern end will be extended to Norfolk, Virginia, or Baltimore, Maryland. Execution of this plan is expected to substantially increase deliveries to the East.

The Atlas Pipe Line Company line from East Texas to Shreveport, Louisiana, is being reconditioned and used pipe will be used to connect this line with that of the Standard Oil Company of Louisiana to Grand Lake on the Mississippi River. The line is then expected to carry between 25,000 and 50,000 bbl. of crude oil per day to the Mississippi to be transported by barge on up the river.

Remaining projects ready for construction consist of an 8-in. line from Tinsley field, Mississippi, to Memphis, Tennessee, to reduce the length of rail and barge hauls; reversal of the Tuscarora Pipe Line Company line from the Ohio boundary to Bayonne, New Jersey; construction of a connecting line between Fostoria and Akron, Ohio, and the enlargement of terminal facilities on the Great Lakes to permit greater barge movements to the East by way of the lakes.

The Office of Petroleum Coördinator announced obtaining an A-1-A priority rating for a pipe-line project to make the refineries of the San Francisco Bay area entirely independent of ocean transportation for their crude oil supply early in June.

The project involves conversion from natural gas to crude oil service of the 24- to 26-in. Stanpac pipe line, extending from Kettleman Hills to the Bay region, and substitution of the Rio Vista gas field as the source of gas supply for communities now served by the Stanpac line, which will provide inland transportation for 100,000 bbl. of crude oil daily to bay refineries.

The A-1-A rating covers mainly the small amount of new steel pipe required to make the conversion possible. Total expenditures for materials will not exceed $1,500,000, it is estimated.

Sponsors of the conversion and supply-substitution project are the Standard Oil Company of California and the Pacific Gas and Electric Company, joint owners of the Stanpac line.

Standard is proceeding to convert Stanpac to crude service by removing compressors on the line, and substituting a number of pumps, all of which are on hand from used equipment. At the same time, by rearranging its facilities and laying some new pipe, Pacific Gas and Electric will substitute Rio Vista for the Kettleman Hills natural gas being moved to the Bay region via the Stanpac line.

The conversion also will necessitate servicing five San Joaquin Valley communities, Dos Palos, Los Banos, Gustine, Newman, and Patterson, from the Rio Vista field.

This will be accomplished by laying a 50- to 60-mile string of pipe along the Stanpac right-of-way to connect with Pacific Gas and Electric's 16-in. line running from near Vernalis to Sacramento by way of Stockton. The 16-in. line already is tied in directly with the Rio Vista gas supply.

THE Petroleum Engineer

MAY, 1942

Ample Availability of U. S. Oil Was No Accident

Exclusive

☆ More than 20 years ago leaders of the industry foresaw need of petroleum reserves for future national emergency and did something about it

by Prentiss T. Moore

ALL other wars have ended. This one will. And when the decorations are passed out to those who have served their country well in its greatest emergency, one wonders what will be handed to that most vilified of all U. S. industries, the petroleum business.

Some facts are so little recognized, are so far out of line with common opinion, that reviewers hardly dare exhibit them lest they be thought fools.

What or who has done more to assure winning of this war than the United States oil industry?

Popular opinion of course realizes the supreme importance of petroleum at this time. It is common knowledge that most of the world's supply of petroleum is here in the United States; also that we have reserves of available surplus sufficient for any emergency for a time at least. If the public does not, war boards at Washington and London do, know how gravely uncertain are other sources of supply available to the United Nations and how gravely ultimate victory is dependent on United States oil wells.

But who knows why we happen to have this so gravely important asset at this critical period?

This reserve of petroleum now available in this country is not an accident of nature. It is not due to great national preparations for national defense. It is not due to federal policies and aid. It is not due to WPA or RFC loans.

PRENTISS T. MOORE

wrote an oil news column for the *Muskogee Phoenix* in 1913—In 1915, went to Tulsa, Oklahoma, as staff correspondent of the *Fuel Oil Journal* of Houston, Texas—Continued in charge of Mid-Continent section of that journal after it moved to New York in 1917 as the *Oil Trade Journal*—In 1919, was in Dallas for a year under contract with the Chamber of Commerce "to put Dallas in the oil news datelines"—From 1919 onward, was an occasional contributor to New York dailies, especially the *Wall Street Journal*, of articles on general aspects of the oil business—From 1920 until into the middle 30's also acted as private correspondent for eastern banking and stock-and-bond houses, as a specialist in the matter of the United States crude oil supply—For the last 17 months has been gathering data for a history of the petroleum industry since the Dissolution Decree.

It is due solely to the U. S. oil industry; to oil policies arising more than 20 years ago, after the First World War had proved the grave need of petroleum reserves for future national emergencies.

The petroleum supply of the United States is the United Nations' greatest assurance of victory. The monumental production of tanks and airplanes and other war machinery moved by or moving on petroleum, now going on in the United States and England, is futile without petroleum; and this nation alone has petroleum in sufficient quantities where the enemy cannot hope to attack it successfully. Outside the United States' resources of oil—about two-thirds of all that is produced in the world—nothing else is quite safe from the enemy. Already the Japanese have seized and are converting to their own use the valuable petroleum deposits of the Dutch East Indies and Burma. Germany and her allies on Continental Europe at this very moment are making a desperate onslaught on Russia to try to cut Russia off from and seize for themselves the highly important petroleum of the Caucasus; no doubt with intent, if successful against Russia, to

continue their conquest and try to seize the Mesopotamian and Persian oil fields.

Where Else Oil?

Where else in the world is oil in quantity? Owing to far-sighted policies of American, English, and Dutch oil men, a big supply has been developed in South America since the First World War—but is South American oil safe from the enemy? Ask the tanker crews that are doggedly braving the perils of sinking by lurking enemy under-sea craft. Much of the South American petroleum must be moved twice, first across water to refineries, next to where it is needed. It is not inconceivable that the South American supply might be cut off; it takes less steel for a submarine than for an ocean-tanker. Mexico has oil—oil that was of great importance in the First World War—but its output is much smaller than twenty-odd years ago and now might be dismissed as negligible.

Left for the United Nations in the way of petroleum immediately available and in all its refined forms and safe from enemy attack is only that reserve supply that the U. S. oil industry has built-up in this country.

Published records of the U. S. oil industry during and since the First World War hold ample evidence to prove that the U. S. oil reserves, now utterly important, are not due to chance but to a drastic revolution in underlying oil policy and the initiation of a program that subordinated profits to building up an underground supply of surplus petroleum.

That the public has not seen this is partly because of that political ineptitude of the oil industry that has so seriously handicapped its public relations for a number of years and partly to the fact that the public was hypnotized ten years ago by the enormous East Texas pool and concurrent discoveries into believing that the growing reserves were due to chance. It has escaped general attention that since East Texas was discovered almost twenty billion barrels of new reserves have been found here in the United States. All petroleum originally in the East Texas pool would be but a fraction of the additions to reserves since it was discovered. As huge as was East Texas, it was quickly seen by oil leaders that continued heavy discovery was essential to the new program. By far the most of the surplus now at wellheads is the fifteen or sixteen billion barrels of new reserves found from 1934 to 1941.

Change in Industry Policy

In the corporation records of such authoritative statistical concerns as *Moody's* or *Standard Statistics, Inc.*, is proof enough of some great change in the economy of the U. S. oil industry since the First World War, as a result of which earnings have been far less than in former days. Earnings of the best-managed oil companies, for more than two decades, have averaged less than those of other great industries. This point was brought out emphatically a couple of years ago by the Temporary National Economics Committee, in an exhaustive survey of the petroleum business. It seems to have been early recognized by oil leaders that the new policy toward the crude oil supply would necessarily have a bad effect on earnings. In 1923, with the new policy dimly taking shape, Amos L. Beaty, then president of The Texas Company, in an address before the American Petroleum Institute, said that he believed "the days of phenomenal earnings are past." Some years later, with the program of building reserves getting under good headway, Walter C. Teagle of the Standard of Jersey stated, in substance, that the American petroleum industry must be content with conducting its business indefinitely on a basis of "large volume and low profits." The nature of the oil-producing business — an unorganized mass of tens of thousands of small producers and a few large ones, with constructive coöperation prohibited by federal law — has made it impossible from the beginning to develop underground reserves along good economic or engineering lines. There was no way to prevent unnecessarily rapid drilling of a new reserve. The first strong evidence that a new policy was in operation with regard to the crude oil supply was in 1922, when, for the first time, major crude oil buyers showed reluctance to build more tankage and store the surplus of a current overproduction or to cut prices of crude oil to those abnormally low levels that had been customary during past periods of excessive production. On the contrary, prices were maintained at levels averaging considerably higher than during similar bearish periods in previous years. (An essential feature of the policy for maintaining reserves, a feature considered from the beginning of the program, was the necessity of "stabilizing prices" at some level that would encourage discovery work to continue.) The obsolete policy that was beginning to be abandoned in 1922, the policy that had been followed for sixty-odd years, had been to preserve average earning power during periods of too much crude oil by checking drilling with abnormally low prices and to absorb the surplus oil into storage tanks. But aboveground storage had begun to lose favor before the First World War was ended. The scarcity of petroleum during that war had concentrated thought on the need to conserve the oil supply to the greatest possible extent. The loss of aboveground storage, through leakage, lightning, and evaporation, caused much concern. Then, with the airplane showing what bombs might do to a tank farm, it was realized that oil reserves that might be needed in war would be safer if underground.

In this third and concluding article by Prentiss T. Moore on U. S. oil reserves, the author throws light on some of the underlying reasons why there was a sufficiency of immediately available U. S. oil when war was declared.

Reserves Before Profits

The multitudinous troubles of the U. S. oil business during the last ten years have not been due to clashing interests of "majors" and "independents" nor to efforts of large companies to squeeze out small businesses nor to "monopolistic practices" nor to "conspiracies in restraint of trade" but were due to the policy that has put the matter of crude oil reserves ahead of profits. Some day historians are likely to treat the Madison cases as a gross miscarriage of justice.

When the United States entered the First World War in April, 1917, President Woodrow Wilson called to Washington leading businessmen of all lines to aid the federal boards in coördinating the nation's productive power for warfare. These businessmen were formed into advisory committees of quasi-official standing. One committee was on petroleum. That committee elected as its chairman Alfred C. Bedford, then president of the Standard Oil Company (New Jersey). During the war years 1917-1918 he concentrated on that war's need for oil, doing his job so well that at a banquet given in his honor soon after the Armistice, the representative of the British Government attending the affair said, "The winning of the war depended to a large extent on the winning of oil by Mr. Bedford."

Bedford was the actual "Petroleum Coördinator" during the First World War, even if acting unofficially. During the war, he said most about the necessity of more drilling then, but

time and again referred to the future, particularly to the need of "a stabilized supply" holding greater reserves. Other oil men expressed the same thought. In 1916, when Cushing's collapse left an acute shortage of crude oil, J. C. Donnell of the Ohio Oil Company expressed the hope of some great discoveries that might afford a more "stabilized" supply. In 1918, the *Oil Trade Journal* quoted anonymously "an executive of one of the very largest oil companies" as saying that the Ranger, Texas, discovery might have found such a vast deposit of petroleum that "it would stabilize the business for twenty years." The thought of a stabilized supply of crude oil, maintained by "stabilized prices," was common in the oil business by the end of the First World War, usually with the collateral thought that the supply should hold reserves for some years ahead.

Birth of Co-operation

Those oil leaders who had served their country at Washington in 1917-1918 during the First World War seem to have returned to their business posts with a graver sense of their own great responsibilities. They had seen, as had the world, how deadly important was petroleum in war and how rapidly war cut into supply. "Utterances" of the period show they felt that a few hundred million barrels of oil in aboveground tanks was utterly inadequate as a reserve for national emergencies. It is possible, knowing foreign affairs as well as some of them did, that they foresaw a future that might easily give birth to other great emergencies. Toward the end of the war, Bedford's public addresses showed more and more of what might be termed national consciousness. They also showed that he felt the U. S. oil industry should forget old feuds and work together after the war, not only for the oil business, but "for the benefit of the nation, the public, and the oil business."

Having quickly become of such public influence that he might have become a power politically had he chosen, Bedford was chiefly instrumental in organizing the American Petroleum Institute. Its purpose has been challenged. In Kemnitzer's stolid book, *Rebirth of Monopoly,* it is argued, with the arguing supported only by argument, that the Institute was intended to rebuild or perpetuate "monopoly." In an anti-trust action begun by the Department of Justice in 1940 is a contention somewhat similar. But it can be urged just as readily and more logically that the Institute was intended only to promote constructive coöperation "for the benefit of the nation, the public, and the oil business." If it was part of a plan of Standard Oil to recreate "monopoly," it has had most peculiar effects. Results of oil policies since the Institute was organized cannot be argued for they can be expressed mathematically. As for Standard Oil—those businesses so known have lost a big percentage of the relative position they held in 1919. As for the oil business as a whole—it has earned much less profit, comparatively, since 1919. As for the public—it has bought its petroleum products at much lower prices since 1919. As for the nation—it has had accummulated for it since 1919 a reserve supply of oil that might prove to be the most important single factor in saving Christian civilization. Organization of the American Petroleum Institute has been a potent influence in aiding the U. S. oil industry to work together, and this has redounded to the welfare of the nation and the public. Standard Oil history, about that time, holds some strange indications. Had Kemnitzer desired, he might have found as much material for a book, not on rebirth of monopoly, but on Standard Oil abandoning old profit policies in favor of public service. Great changes then were going on in Standard Oil. The elder Rockefeller was giving away the last of his shares to great foundations for the benefit of humanity. All the Standard companies were reducing par value of shares and listing them on stock exchanges, to encourage larger public ownership. The younger Rockefeller was publicly urging, as a general policy for all industry, more attention to company-employee relationship. The companies were putting employee-benefit ideas into practice. All this showed signs of some sort of revolution within Standard Oil itself.

Need for More Oil in 1918

When war ended in 1918, there was such shortage of oil at U. S. wellheads that the domestic industry concentrated for the next 12 months on an enormous drilling campaign to get supply to balance consumption. By the end of 1919 it looked as though this campaign had failed. Supply was still behind current demand. The necessity of protecting what oil was left in the United States by strong American oil development in foreign lands was generally urged. England, through her government and her oil men, had begun very vigorously to develop British-owned supplies, largely because of the general belief that the U. S. resources of oil were approaching exhaustion, or at least chronic shortage.

But continuation of the extraordinary U. S. drilling campaign through 1920—under stimulus of extraordinarily high prices for oil—were getting such results by 1921 that thoughts about a reserve supply began to come back. By this time Bedford, then chairman of his company's board, had shifted his attention to foreign affairs—leading a movement to get the U. S. Government more interested in aiding the development of American-owned oil supplies abroad, against the discriminatory policy of an Anglo-French-Dutch combination,† and Walter C. Teagle, the New Jersey's president since 1918, took over leadership of the domestic movement for better oil supply. An address he made to the American Petroleum Institute late in 1921, with oil temporarily abundant again, indicates that policy was then forming for some new method of providing for more adequate oil reserves in this country:

"There is an uncontrollable factor and element of chance peculiar to petroleum. . . We are without the stabilizer of reserves. . . . No practical method has yet been devised of economically utilizing the surplus of today as against the shortage of the far tomorrow. . . . The pathway to the ideal position would seem to be to maintain production at a given level, irrespective of current requirements. (Stocks then were equivalent to a 136-day supply.) But why not as a cushion against extraordinary demands accumulate a petroleum reserve for a year instead of for only 136 days? But cost of carrying in storage, 40 cents per bbl. annually, (is prohibitive). . . . Such a violent price adjustment as we have experienced in our own and other industries (in the 1921 depression) is perhaps not the ideal medium of establishing equilibrium between supply and demand. . . . It will not be amiss to ask ourselves if we have done all that we could for stabilization. . . . It may be asked if the industry should not aim at an established policy."

New Policy Crystallizes

So far, it was somewhat uncertain thinking. The 1922 situation (referred to earlier in this article) cleared thought considerably, and saw actual preliminaries of a policy of not storing oil aboveground and of maintaining prices at a level that would encourage new discoveries. In two or three years, a desired new policy had been rather definitely formulated, and was often heard discussed in oil offices: "Prices should be stabilized at a level that would encourage continual discovery; output of new fields should be prorated to an amount no more than needed currently; any excess oil should be

†In 1920, the British and French governments signed a formal agreement for merging their oil interests in their own domains, Russia, Mesopotamia, and other lands; and, with the Dutch interests, were making it harder for American companies to exercise their old foreign privileges.

stored in the ground, by keeping it there."

The possible need of petroleum for future national defense was kept in mind. In 1925, an American Petroleum Institute committee of eleven prominent oil leaders, in analysing the United States oil supply and its future possibilities, commented, in the second paragraph of its report: "It is reasonable to assume that a sufficient supply of oil will be available for national defense. . . ." This report did not go into the matter of reserves of available surplus, as drills were still unable to do more than keep up with consumption, with all U. S. oil wells flowing or pumping at maximum capacity. (It was estimated that then there were 5,300,000,000 bbl. of recoverable oil in U. S. oil fields.) Until 1927 about all that could be done was to keep prices at an average that would allow wildcatting to continue. Supply was still being regulated by price. A study of the price chart from 1921 to 1926 reveals a fluctuation different from that of former years, usually with very rapid rebounds from the occasional low levels forced by excessive output. Storage of oil aboveground was still going on despite growing objection to that practice, but so far that was the only way of accumulating any reserve whatsoever. Old methods of unrestrained competitive drilling and full flow of oil wells were still followed, largely because of lack of enough new discoveries for the drills to get well ahead of a rapidly increasing consumption. United States oil was still being used up as fast as it was available. Larger companies were doing all they could to augment the domestic supply by development of South American fields.

In 1927, the sustained work of exploration began to get ahead. Great areas were found for high-yield development operations. Immediately was seen working the policy that had begun to be clearly defined some years before —of prorating output of fields capable of surplus production and keeping the surplus in the ground, and at the same time maintaining oil prices at a level that, although lower comparatively, would allow discovery to go on. At that time the National Administration was taking a friendly interest in the oil business, was cognizant of the program to build up reserves; and as soon as it was seen that the drill was at last getting ahead of consumption, there was much consultation between Washington and the oil industry as to methods for preventing wasteful exploitation of reserves. President Coolidge personally took much interest and dealt with the business through a board of his own creation, the Federal Oil Conservation Board, of which the head was Secretary Hubert Works of the Interior Department. In 1927, there was informal and formal discussion between Secretary Work and leaders of the oil business. The subject was gone into exhaustively in a joint letter to Secretary Work from Teagle of the Standard of New Jersey and W. S. Farish, then president of Humble Oil and Refining Company, now president of the Standard of New Jersey. General agreement was that unless producers and landowners could be induced into voluntary contracts for orderly development of new reserves — something quickly seen to be impossible in most cases—the best things would be to get State regulation of oil output. Thus began general legal proration of oil fields, wherever states could be induced to enact the necessary legislation.

Building Reserves

From 1927 to date, the story is merely a continuation of the program to build and maintain reserves, regardless of the effect upon earnings, and regardless of the attacking hostility of the National Administration since 1933. Why this hostility is another question. The record indicates it is largely due to a misunderstanding of what the oil business has been trying to do and why. That its national-benefit program has not been understood or appreciated by the national government is much the oil industry's own fault in not telling the public what it was doing.

Had there been monopolistic intent in those new policies that began to appear with the organization of the American Petroleum Institute 23 years ago, certainly a remarkable opportunity was lost by the suppositious "monopolists" ten years ago when during the "Great Depression," Oklahoma City and East Texas were threatening to bankrupt all the oil business except the richest and most powerful units. All that would have been necessary was merely to step aside and let nature take its course. Oklahoma City and East Texas would have drowned that thick forest of young competitors who had arisen since 1916. Some oil men feared that would happen. But the large companies stood emphatically by the policy of trying to keep prices sufficiently stabilized for discovery to continue, of prorating output to demand, and of keeping the surplus in the ground.

Regulating Oil Output

Instead of taking advantage of a phenomenal superabundance of oil to wipe out competition and rebuild monopoly, the major companies were chiefly instrumental in getting state legislatures in 1933 to enact laws for regulating oil output so that all could survive and the building of reserves continue. The general counsel of the Standard of New Jersey's producing branch in the Oklahoma-Kansas district worked himself literally into nervous prostration in the spring of 1933 helping to frame and get through the legislative hoppers measures that guaranteed to small producers, for the first time, their fair share of the production of an oil field.

So far as their own pocketbooks were concerned, the major companies, which have had to bear the brunt of administration hostility and much vilification from other sources, would have fattened up again by standing aside and allowing competitors to be ruined by their own oil. Instead, the majors condemned themselves to the poorest ten years of profits in their history, the years 1931 to 1941.

To all elements in the U. S. oil-producing business is due some of the credit for the nation's oil reserves, for all have shared in causing those discoveries that have made the reserves, but none has done more than the abused major companies or at greater cost to their stockholders.

The U. S. oil industry, however, is due sharp criticism for one thing—hiding its light under a bushel. As W. S. Farish said in the 1940 report of the Standard of New Jersey to its employees, apropos of something else:

"It is characteristic of the oil industry that most of its contributions to material progress have been of the behind-the-scenes variety."

When it decided to work its affairs for the best interests of the nation, the oil industry should have engaged some great special counsel—as it did for awhile when it engaged Charles Evans Hughes in 1926—to represent it before the American people. If ever a great industry needed a top-rank public relations man, the oil business does.

It is a public wrong, as unfair to the American public as to the American oil business, that some falsely prejudiced Assistant U. S. Attorney General could go before a Congressional Committee, as was done at Washington a few weeks ago, and vilify a great American oil business that has worked longer to prepare the nation for terrible emergency than any federal bureau. Reference is to the ugly attack of Thurman Arnold of the Department of Justice on the Standard Oil Company (New Jersey) in a matter of rubber patents that the Standard once owned jointly with German interests.

It may be all right, from some standpoint, to wear a crown of thorns for great duty well done; but, as it has been fully earned, why not the Distinguished Service Medal instead?

——— ☆ ☆ ☆ ———

So, You Want to be a Petroleum Engineer?

PART 5—*Petroleum Engineering Schools of the United States*

by Lester C. Uren

Professor of Petroleum Engineering, University of California

A photograph and biographical sketch of the writer can be found on Page 7 of the January issue of *The Petroleum Engineer*, in connection with Part 1 of this series.

AT least 20 different institutions that offer organized curricula in the field of petroleum engineering are worthy of mention in any survey of schools, colleges, and universities serving this field. Their curricula have been presented in tabular form permitting ready comparison, in the second article of this series.[1] Each institute presents certain advantages worthy of careful consideration by the prospective student. Space limitations do not permit of complete descriptions, but a brief statement concerning each will perhaps serve as a guide for one wishing to make a selection. Catalogs of courses, with information concerning admission requirements, fees charged, and general rules and regulations may be had by addressing a request to the registrar of any of the institutions listed. Officers of administration and instruction named will confer with and advise prospective students. For convenience, the institutions are grouped geographically.

Eastern Institutions

Four institutions in eastern states of the Appalachian region offer separate petroleum engineering curricula. Two are in Pennsylvania, one in West Virginia, and one in Ohio.

Pennsylvania State College. Pennsylvania State College is situated at State College, a very attractive city of about 6200 people, at or near the geographic center of the State of Pennsylvania. Petroleum engineering is here represented by a separate department that is a division of the School of Mineral Industries. Petroleum engineering enrollment in a recent year was 80 students. Dean Edward Steidle is the principal executive officer of the school. Assistant Professor S. J. Pirson is in charge of the Department of Petroleum and Natural Gas Engineering, which was established in 1929. In addition to Professor Pirson, Associate Professor S. T. Yuster and Assistant Professors F. C. Todd and H. Krutter, with Instructor L. T. Bissey comprise the teaching staff.

The institution is well known for its promotion and support of research in the field of oil and gas technology, particularly in connection with secondary recovery methods of oil-field exploitation. Dr. A. W. Gauger is director of the Mineral Industries Experiment Station. Research fellowships are supported coöperatively by oil and gas producers of the region and four research assistants in addition to the teaching staff are currently employed in the conduct of research projects on a part-time basis. Instructional and research facilities in the field of petroleum engineering and all related fields are excellent. The Department of Petroleum and Natural Gas Engineering is housed in the Mineral Industries Building, one of the finest and most modern of its kind in the United States. Most of the students live in college-owned dormitories.

Many oil and gas fields and refineries of the northern and western Pennsylvania region can be reached from State College within a few hours by excellent paved highways. The College has been successful during recent years in attracting many men active in the oil and gas industries of Pennsylvania to periodic technical meetings arranged by the staff of the School of Mineral Industries and held under the auspices of the College. Through its Extension Division, the school is also active in carrying instruction in oil and gas technology to men employed in the industry throughout the state.

University of Pittsburgh. One of the pioneer institutions in the field of petroleum engineering education, the Department of Oil and Gas of the University of Pittsburgh was organized as a division of the School of Mines as early as 1912. Bachelor of science degrees are offered in petroleum engineering and petroleum geology. E. A. Holbrook is dean of the Schools of Engineering and Mining and Professor R. E. Sherrill is head of the Department of Oil and Gas Production. Assistant Professor G. L. Yates and Instructor E. C. Doty conduct many of the petroleum engineering courses.

Situated in one of the more attractive sections of the city of Pittsburgh, this institution was founded in 1787. It now has a student attendance of about 6500 full-time and many more part-time students. Nearby are the Carnegie Institute of Technology and the excellent facilities of Pittsburgh's Carnegie Institute, with its magnificent library, museums, art galleries, and music hall. These facilities, together with those of the nearby Mellon Institute for Industrial Research and the

Stratton Hall, Colorado School of Mines, Golden

[1] *The Petroleum Engineer*, February, 1942, pp. 84, 87.

U. S. Bureau of Mines Pittsburgh Experiment Station, make this one of the most impressive education and research centers in the United States.

Pittsburgh, a city of 672,000 people, is the center of an important manufacturing, steel, and coal producing district and is headquarters for several oil and gas companies and oil-field equipment and supply concerns. Because of the many engineers, geologists, and industrial executives resident in Pittsburgh and vicinity, it has become an important center for engineering society meetings and the University has been able to attract to its instructional staff engineers, geologists, and executives prominent in their respective fields. Pittsburgh has also become an important center for extension work among college graduates employed in the local industries and the University is taking an active part in this field of education.

West Virginia University. Situated in northwestern West Virginia, in the City of Morgantown, the University of West Virginia was founded in 1867. A mountainous, forested region, the surrounding countryside is scenically attractive. Morgantown has a population of about 16,600 and the University has about 3500 students. Petroleum engineering instruction is here a phase of the work of the School of Mines, one of the two "options" under the mining engineering curriculum providing for specialization in "Geological and Oil and Gas Engineering." Professor D. L. McElroy is director of the School of Mines and courses in oil and gas technology are conducted by Associate Professor W. A. Staab. The School of Mines has recently occupied a splendid new mineral industries building, one of the finest in the United States.

Closely associated with the Departments of Chemical Engineering and Geology and the West Virginia Geological and Economic Survey, the School of Mines is well equipped to serve the mineral industries of this state. Coal mining is the principal mineral industry of this region and the emphasis is on this phase. There have been substantial petroleum and natural gas industries in this state since 1865, however, and many of the oil and gas fields of western West Virginia that reached production peaks during the last century are still commercially productive. Their exploitation by secondary recovery methods will in future engage the attention of many petroleum engineers.

Ohio State University. Ohio State University is situated in the capital city of Columbus, an attractive city of about 306,000 population. Supported by appropriations from state and federal governments, the University is well developed in many departments and has an investment in land, buildings, and equipment of about $26,000,000. Petroleum engineering instruction has here been a development within the Department of Mining Engineering, beginning in 1925, and the curriculum followed by petroleum engineering students leads to the degree of bachelor of science in mining. The School of Mineral Industries, which includes petroleum engineering in its scope, is a division of the College of Engineering.

The University attracts a large group of graduate students, has excellent facilities for advanced training in many departments, and offers the usual professional and higher degrees on completion of one or more years of graduate work. Opportunity is afforded for graduate research in the University's Engineering Experiment Station and coöperative relationships exist with the Battelle Institute, situated on an adjoining tract. Graduate research fellowships and scholarships are available in many fields of study.

Professor H. E. Nold is professor of mining engineering and has general supervision of the work of the Mining Department, but petroleum engineering courses are in charge of E. V. O'Rourke, professor of petroleum engineering. Most mineral industry students at Ohio State specialize in mining, metallurgy, and ceramics, but the State of Ohio for many years has had a substantial oil and gas industry. Many opportunities for petroleum engineers still exist in this region, particularly in the conduct of secondary recovery operations in the oil fields of southeastern Ohio.

Mid-Continent Institutions

Six schools and colleges in the Mid-Continent area of the United States offer curricula in petroleum engineering, widely scattered throughout this important oil-producing region. These are the University of Illinois, the University of Minnesota, the University of Kansas, the Missouri School of Mines, the University of Oklahoma, and the University of Tulsa.

University of Illinois. The University of Illinois is situated in the adjoining cities of Urbana and Champaign, in central Illinois, supporting a population of about 37,000. Founded in 1867, the University of Illinois is one of the larger universities of the United States. The teaching staff at Urbana recently numbered 1174, of which number 169 were employed in the engineering departments. Student enrollment in a recent year was in excess of 14,000. Petroleum technology is not emphasized, however, and the number of students enrolled in this phase of engineering is small.

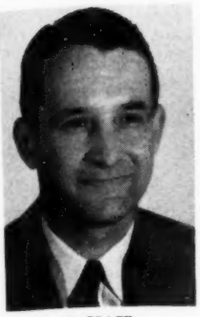
Petroleum engineering is here recognized as a phase of mechanical engineering, students wishing to specialize in this field following a slight variation of the mechanical engineering curriculum. R. F. Larson, assistant professor of mechanical engineering, conducts two courses dealing with petroleum production engineering in the Department of Mechanical Engineering, which is presided over by Professor O. A. Leutwiler. Specialization in petroleum engineering was initiated in 1934. Some specialized courses in petroleum geology are also offered in the Department of Geology by Professor F. W. De Wolf.

The University of Illinois Engineering Experiment Station, organized in 1903, is well known for its many excellent bulletins and circulars presenting the results of research in many different phases of engineering. Opportunity is here afforded for graduate students seeking research fellowships. The University possesses many scientific collections and one of the largest technical libraries in this section of the country. The Illinois State Geological Survey also makes its headquarters at the University in the modern Natural Resources Building and the adjoining Geological Survey Laboratory. This organization has prepared and published many bulletins concerned with geological reports on the oil and gas resources of the State of Illinois. This state for many years has produced small quantities of petroleum, but during recent years, exploitation of newly discovered reserves in southern counties has placed the state in fifth place among the producing states.

University of Minnesota. Situated in the Minneapolis-St. Paul metropolitan district, the petroleum engineering student at the University of Minnesota enjoys most of the advantages that are derived from affiliation with a complete university, with a large student body in an important urban center of population. The district population is about 780,000 and enrollment in the University is about 16,600.

In this state-supported university, petroleum engineering is taught as a phase of the work of the School of Mines and Metallurgy, and petroleum engineering courses of instruction are centered in the Department of Mining and Petroleum Engineering. The Mining and Metallurgy Building, completed in 1911, houses all mineral industry activities, including petroleum engineering. Professor E. H. Comstock is head of the Department of Mining and Petroleum Engineering, but petroleum engineering instruction is largely entrusted to Professor W. H. Parker,

Meet the Faculty



B. C. CRAFT
Louisiana State University

E. V. O'ROURKE
Ohio State University

R. F. LARSON
University of Illinois

W. D. LACABANNE
University of Minnesota

F. G. TICKELL
Stanford University

R. E. SHERRILL
University of Pittsburgh

A. B. STEVENS
Texas A. and M. College

W. A. STAAB
West Virginia University

R. F. NIELSEN
Pennsylvania State College

GEO. FANCHER
University of Texas

B. I. ROUTH
New Mexico School of Mines

J. P. HAYS
Texas A. and M. College

E. A. STEPHENSON
University of Kansas

W. H. CARSON
University of Oklahoma

SYLVAN CROMER
Louisiana State University

H. H. POWER
University of Texas

W. H. PARKER
University of Minnesota

C. F. BARB
Colorado School of Mines

HAROLD VANCE
Texas A. and M. College

G. L. YATES
University of Pittsburgh

W. F. CLOUD
University of Oklahoma

I. C. UREN
University of California

R. L. LANGENHEIM
University of Tulsa

G. W. NOBLE
Missouri School of Mines

F. C. TODD
Pennsylvania State College

J. F. DODGE
University of Southern California

G. M. STEARNS
University of Oklahoma

S. T. YUSTER
Pennsylvania State College

C. R. HORN
Texas Technological College

W. C. BEDNAR
University of Oklahoma

Geology and Petroleum Engineering Building, Louisiana State University

professor of mining and petroleum engineering, and W. D. Lacabanne, instructor in petroleum engineering. A course in the geology of petroleum is offered in the Department of Geology by Professor W. H. Emmons, a prominent authority in this field.

Situated in a state in which the mining of iron ore is the principal mineral industry, it is natural that this and related phases of ore dressing and metallurgy should be emphasized and should appeal to the great majority of the students of the School of Mines and Metallurgy. The group of students specializing in petroleum engineering has thus far been small. Minnesota has no oil-producing industry of consequence, but important oil fields are found in the Mid-Continent and Gulf Coast areas to the south and the Rocky Mountain region to the west. A three-weeks' field trip into one or another of these areas toward the end of the junior year, under faculty guidance, is an important phase of the instruction in petroleum engineering.

The Mines Experiment Station, which houses also a regional laboratory of the U. S. Bureau of Mines, affords resources in equipment and personnel for graduate research in the field of the mineral industries.

Missouri School of Mines. The Missouri School of Mines and Metallurgy is located at Rolla, Missouri, a city having a population of about 5100, situated 110 miles south of St. Louis. A division of the University of Missouri, the seat of which is at Columbia, Missouri, the School of Mines was established in 1871 and derives its support chiefly from state and federal funds. Petroleum engineering instruction at this institution was initiated in 1920 and is considered a phase of the work of the Department of Mining Engineering. Professor C. R. Forbes is head of this department but instruction in petroleum engineering is conducted by Associate Professor G. W. Noble and J. W. Dunn, instructor in petroleum enginnering. The petroleum engineering program, though considered an option within the mining curriculum, is nevertheless, a complete curriculum and compares favorably with that of other institutions specializing in this field.

Enrollment in the School of Mines during the academic year 1939-40, was 895 students, of which number 58 were petroleum engineering students. A program in oil refining is also offered as an option under the chemical engineering curriculum, but this field attracts fewer students than the petroleum engineering program. During recent years, the School of Mines has offered curricula in mechanical, electrical, civil, and chemical engineering, but it is reported that the institution may in the future, confine its activities to the mineral industries and closely related fields of study, which, of course, would include petroleum engineering.

Lead, zinc and coal mining, and production of ceramics products are important industries in this area, and most of the students in the School of Mines are preparing for participation in them. The petroleum industry of Missouri is comparatively unimportant. The great Mid-Continent oil fields of Arkansas, Kansas, and Oklahoma, however, are but a few hundred miles to the south and west and petroleum engineering students of the School of Mines have little difficulty in obtaining field contacts.

The State Mining Experiment Station is conducted as a division of the School of Mines and the Missouri Geological Survey and Mississippi Valley Experiment Station of the U. S. Bureau of Mines maintains offices, laboratories, and research staffs on the school campus. These agencies afford opportunities for students, particularly graduate students, to participate in mineral industry research and investigative work.

University of Kansas. The University of Kansas is at Lawrence, Kansas, an attractive city having a population of about 14,400. The University was organized as early as 1855. The School of Engineering and Architecture was established in 1891, but it was not until 1937 that instruction in petroleum engineering was inaugurated in a separate Department of Petroleum Engineering. The School of Engineering and Architecture offers complete programs of study in eight branches of engineering, of which petroleum engineering is one. Both four- and five-year curricula are offered, with a separate bachelor's degree for each. The petroleum engineering curriculum places emphasis on the fundamentals of engineering, geology, and petroleum technology. A geological option is offered within this curriculum.

Professor E. A. Stephenson, well known in petroleum industry circles throughout the United States and active in affairs of the Petroleum Division of the American Institute of Mining and Metallurgical Engineers, is chairman of the Department of Petroleum Engineering. J. I. Moore is instructor in some of the petroleum engineering courses. J. J. Jakosky, dean of the School of Engineering, and an authority in the field of geophysics, conducts courses in this subject and in industrial administration, primarily for petroleum engineering students. Professor C. M. Young, head of the Department of Mining, conducts a course in the regulation and measurement of natural gas. Professor K. K. Landes, chairman of the Department of Geology, conducts a course in petroleum geology.

Funds have recently been appropriated for a new mineral industries building, expected to be one of the finest of its kind in this part of the United States. The Petroleum Engineering Department and others related to mineral industry instruction will occupy this building when it is completed. The Geological Survey of Kansas is a division of the University and makes its headquarters on the University campus. The University's library and museums in various fields of science are outstanding.

For many years Kansas has had an important petroleum producing industry and has recently ranked sixth among the producing states.

EDITOR'S NOTE: The discussion of Petroleum Engineering Schools will be continued in an early issue.

——— ☆ ☆ ☆ ———

P 615.635.4

Recent Developments in Cathodic Protection of Bare Pipe Lines[1]

Protection of pipe lines from corrosion important from standpoint of steel conservation

by G. R. Olson

Corrosion Engineer, United Gas Pipe Line Company

IN calculating the economics of cathodic protection it appears that consideration is frequently given to only part of the corrosion picture. For example, it is often said that the expense of cathodic protection is negligible because the costs are only a fraction of the total line or coating costs. In the usual practical pipe-line installation, one or more of the several available methods of corrosion protection are used. Perhaps coatings, of various types, cathodic protection, and extra pipe wall thickness are the most popular methods and they are used either separately or in combinations of two or more.

Underground pipe lines are seldom laid unless it is expected that there will be a need for a means of transporting a commodity for many years. The fundamental objective is to provide continuous transportation over long periods at the lowest possible unit cost. For this reason, it appears that all corrosion studies should show the effect of each plan considered on the total average annual cost, which, of course, includes fixed charges as well as operation and maintenance costs. In a practical sense no method of corrosion control is perfect and there will always be at least a few corrosion leaks over long service periods with associated costs for repairs, damages, and loss of commodity. At present there is not sufficient detailed data to estimate accurately some of the factors involved, but it seems that an attempt should be made in each case to arrive at a reasonable approximation for each item.

Economics of Protectors

Most pipe-line operators and engineers are familiar with the application of cathodic protection to coated lines as many successful installations have now been in operation for years. In fact, application and design methods have already become standardized to some extent, at least for cross-country coated lines. Under those conditions the coating itself represents the principal part of the investment for corrosion control. Although such cathodic protection costs appear low, it does not necessarily follow that the lowest possible total average annual cost of corrosion protection over long periods is being obtained. We have considerable experience data regarding the behavior of different types of coatings under various field conditions, but it appears that there is a great need for more precise data on the real cost of various types of coatings. Coating costs are usually included in general pipe-line contracts that are difficult to break down in a reasonable manner. The savings in handling costs that would be realized if pipe were laid bare are some of the items difficult to evaluate.

Experience seems to indicate that even the lower cost coatings are frequently effective if used with cathodic protection. When sufficient practical data are available to weigh carefully the importance of the many factors involved and accurately determine the long term economics, it may be found that lower cost coatings combined with cathodic protection, or even cathodic protection alone, may be the ultimate answer to most corrosion problems. In this connection it should be remembered that cathodic protection can be applied at any time during the life of a line, but coating must be applied before the pipe is covered. In the practical application of coatings the tendency is to apply them the full length of new lines due to difficulties in predetermining corrosive sections. In the past our organization has been very busy with urgent problems in connection with sections of older bare lines. For this reason, the above problems have not been given the detailed study they deserve, although they do have considerable bearing on cathodic protection of bare lines.

A number of years ago several relatively short sections of the company's older bare lines became so seriously corroded that it would undoubtedly be necessary to carry out extensive reconditioning and/or replacement jobs if corrosion were not brought under control within a few years. Therefore, a study was begun to determine whether these lines could be effectively protected with cathodic protection at a reasonable cost. Experience with designs that the company had used up to that time showed that they would not be effective for this type of application. Designs used by other organizations for bare line protection were found to be either inadequate or too high in first cost to justify as an alternative to reconditioning the particular sections of line under consideration. Field tests on numerous sections of bare line showed that frequently sections are found where it is impossible, with a reasonable output, to obtain full protection spread on a welded line of more than 600 to 1000 ft. from a single ground bed. This indicated that

G. R. OLSON

upon graduating from the University of Wisconsin in 1922 with a degree in electrical engineering, joined the staff of the Utah Power and Light Company and remained with that company until 1929—From 1929-34 he was with the electrical consulting division of the Electric Bond and Share Company, his work taking him to various properties of that company, a part of his time being spent in Mexico —In 1934 he transferred to client companies in Bombay, India, where until 1939 he was general superintendent of operations and construction on the interconnecting high-voltage electric power system serving that area—In March, 1939, he was placed in charge of the corrosion department of the United Gas Pipe Line Company, Shreveport, Louisiana.

[1]Presented at Annual Meeting of Cathodic Protection Section, Petroleum Industry Electrical Association, April 24, 1942, Shreveport, Louisiana.

it would be necessary to build electric distribution lines paralleling the pipe in order to obtain sufficient distributed capacity and purchased electric energy at a low unit price.

Design of System

After a great deal of study and careful consideration of many suggestions, a design was developed in 1940 that appeared to be satisfactory and that, according to estimates, could be applied to the particular sections of line under consideration at an average annual cost for 20 and 30 year periods that would be economical as an alternative to uncovering, reconditioning, and coating the pipe. Briefly, this design consisted of building an electric power

Fig. 1

line parallel to the pipe line, with a separation of about 25 ft., utilizing long-span construction, high-strength conductor, and other details of design that have been developed by the electric utilities for low cost rural extensions. Ten 35-ft. poles were used on the average per mile of line. A single 2300-volt conductor was mounted on a pole top insulator and the single 110-volt conductor was attached to the side of the pole with a bracket and spool-type insulator. The pipe line was used as a common return for both primary and secondary, thus eliminating the need for two extra pole-line conductors. At intervals of approximately 1½ miles small standard distribution type transformers were used to step down the supply voltage from 2300 volts to 110 volts. A small rectifier unit was mounted on each pole and an anode usually consisting of a single joint of junk pipe, was installed near the base of each pole.

The small rectifier units were especially designed to obtain low cost and flexibility in adjustment of output ratings to suit actual field requirements under service conditions. The housing itself is of minimum size with double wall and ample free space for ventilation. It is made of sheet metal and so designed that it can be manufactured in any sheet metal shop. It is transported knocked-down and can be quickly assembled at site without the aid of special tools. The inner housing is also used to support the rectifier stacks and the tap-changing transformer is mounted on a simple pole bracket that supports the complete unit. The sides of the inner housing are made with slip joints so that they can also be easily removed providing ready access to both sides of the unit for maintenance work. A receptacle is mounted in the lower part of the housing so that unit outputs can be taken with a portable plug and meter without opening the housing. The outer housing can be lifted off easily and, in the later design, is provided with louvers instead of circular vents for ventilation. All non-essential equipment and gadgets have been eliminated in these units.

Provision has been made in the design of the inner housing so that 18 different combinations of current and voltage output ratings can easily be obtained by adding or subtracting individual rectifier stacks and making minor connection changes. In addition, the usual range in output adjustments are, of course, provided for each rating. This eliminates the necessity for accurate predetermination of output capacity that has usually been considered essential. Also, the unit rating can be adjusted easily after the installation has been in service for a time and thus maximum operating economy is obtained on each unit. Fig. 1 shows a typical unit of this type with the outer housing and side walls of inner housing removed. This particular unit is equipped with copper-oxide rectifier stacks for a rating of 4.8 volts, 30 amp. Fig. 2 shows a similar unit with selenium rectifier stack rated at 9 volts, 6.7 amp. The unit in Fig. 3 is equipped with a copper-oxide rectifier stack for a rating of 6 volts, 7.5 amp.

Installations

During 1941 eight separate installations utilizing these designs were placed in service protecting a total of about 60 miles of bare and poorly coated pipe. The actual total current requirements and installation costs were slightly less than the estimates used in the preliminary studies. In all cases the desired pipe-to-soil potentials were readily obtained although numerous changes have been necessary in individual rectifier capacities. In fact, after 6 to 12 months' service units are occasionally found in which changes in installed rectifier capacity are desirable or necessary. Pipe-to-soil potential measurements are used as a guide in adjusting unit outputs, but in the final analysis the corrosion leak record is always used in determining the efficiency of any installation. In all cases the corrosion leaks have been falling off very rapidly, but it is believed that at least two years' operation will be necessary before it will be possible to determine the degree of corrosion control obtained. One reason for this is that in the case of gas lines small corrosion leaks sometimes exist for extended periods before being found. In addition, as a result of increased defense requirements, most transmission lines are periodically being subjected to increased

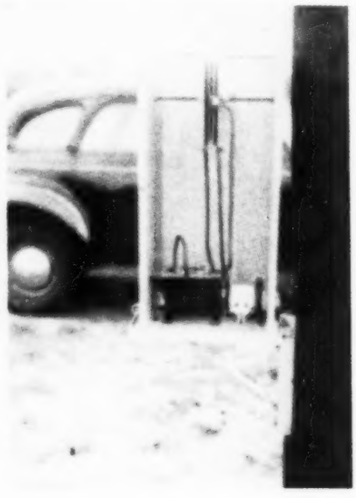
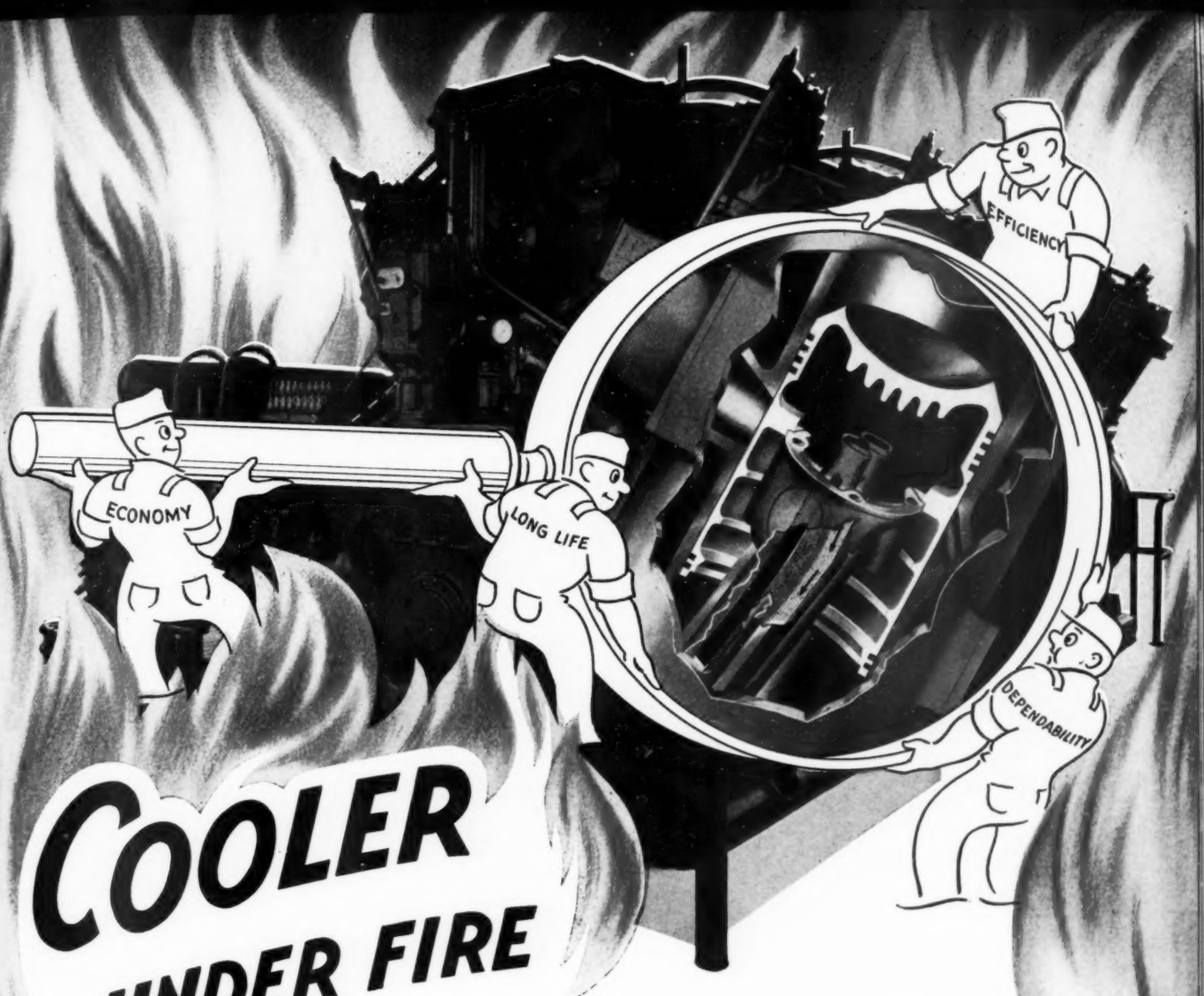


Fig. 2

pressures during peak load periods that cause weak spots to blow out, thus confusing the corrosion picture.

The first installation utilizing this new type design was placed in service in January, 1941, on a 20.9-mile section of 8-in. bare line south of Wichita Falls, Texas. The curves on Fig. 4 illustrate the essential data of interest in connection with this installation. It should be pointed out that under practical conditions with an installation as large as this, it is physically impossible to obtain data representing simultaneous conditions. This is particularly true of this installation where changes are still being made for experimental purposes. Mile posts are laid off on the straight double line in the center of the figure and location of coated sections of pipe line that resulted from replacement and reconditioning work in past years are indicated by heavy black sections. Locations of the 148 units and their relative spacing are shown by vertical arrows. Although it was originally intended to install ten small units per mile throughout this installation, right-of-way difficulties



COOLER UNDER FIRE

No overheating of pistons to cause pre-ignition trouble in the Type G-MV Compressor! Power pistons are efficiently cooled by a continuous flow of oil under the crown.

Lower piston temperatures, through oil-cooling, also permit closer clearance between piston and cylinder. This minimizes blow-by and piston slap, decreasing fuel waste and mechanical wear.

It is such carefully engineered details and rugged construction that enable Cooper-Bessemer compressors and gas engines to continue to perform year after year, so efficiently, so economically and so trouble-free.

TYPE G·MV ANGLE COMPRESSOR

THE COOPER-BESSEMER CORPORATION
MOUNT VERNON, OHIO
Plants: Mount Vernon, Ohio and Grove City, Pa.
New York City Washington, D. C. St. Louis, Mo. Tulsa Shreveport
Dallas Houston Los Angeles Pampa, Texas Greggton, Texas

by Cooper-Bessemer

ENGINE BUILDERS SINCE 1833...

made it necessary to build the electric distribution line around certain property. Hence, in those sections larger units were usually installed near the point where the power line left the pipe line and again where it approached the right-of-way. Curve No. 1 shows the soil resistivity as measured with a Megger, with 5-ft. electrode spacing, at intervals of about 500 ft. along this section of line. It will be noted that soil resistivity varies over wide limits, but usually exceeds 1000 ohms per cu. cm.

Curve No. 2a shows the pipe-to-copper-sulphate plug potentials along this line in July, 1941. In all potential measurements the plug was placed on the surface of the ground immediately over the pipe line. Curve No. 2b shows a similar potential curve from field measurements made in April, 1942. The pipe-to-soil potential was as low as 0.7 volt at a number of points, but, although changes have since been made, it is believed that the current densities were sufficiently high to provide effective protection. At a few other points these potentials were in excess of 1.4 volts. This curve can, of course, be flattened out considerably, with corresponding increases in operating efficiency, by changing to rectifiers and/or additions to ground beds. This being the first installation of its kind, ground beds were purposely designed for short life and it is expected that additions will be necessary in 3 to 5 years. It is believed that long before these additions become necessary, however, sufficient detailed field data will be available to show the exact requirements at each location. In addition, it is also hoped that the type of ground bed now being used will become obsolete in less than 5 years. The total d-c. current drained from 20.9 miles of line decreased from 724.8 amp. in July, 1941, to 597.2 amp. in April, 1942, and there have been some marked changes in pipe-to-soil potentials at numerous points. As of April, 1942, and after subtracting 64 amp., which is being supplied to foreign line crossings and parallels, the average current drained per sq. ft. of pipe surface exposed amounted to 2.40 milliamp.

Before it will be possible to determine the average current density in sections of pipe adjacent to each of the 148 units, it will be necessary to make detailed field tests between units to determine the exact points on the pipe where the influence of one unit drops off and the adjacent unit picks up. Due to shortage of field engineers under existing conditions, it may be impossible to obtain these additional data in the near future. The total average a-c. electric energy consumption for this installation is approximately

Fig. 3

6000 kw-hr. per month and the overall efficiency including distribution lines, transformers, and rectifier units, is approximately 49.5 percent.

Curve No. 3a shows the amp. output of each unit as of July, 1941, and No. 3b was plotted from similar data taken April, 1942. The d-c. watts output for each unit has been plotted in Curves No. 4 and No. 4a for July, 1941, and April, 1942, respectively. These curves show total unit outputs including that supplied to foreign-owned lines.

The chart in the upper left-hand corner shows the corrosion leaks repaired on this 20.9-mile section of line accumulated annually for the last five years, the totals of which are:

1937	72
1938	317
1939	454
1940	468
1941	302

For the 12-month period ending April 1, 1942, only 105 corrosion leaks were repaired as compared with 525 for the 12 previous months. This is a reduction of 5 to 1. It is known that a large percentage of the 105 leaks that were repaired during the last 12 months were due to increased operating pressures during the fall and winter. A study of past monthly peak operating pressures on this line shows that during last fall and winter line pressures were reached that exceeded previous maximums by 55 lb. per sq. in., or 23.7 percent.

Another installation utilizing similar designs was placed in service in February, 1941, on a 4.8-mile section of bare 16-in. line near San Antonio, Texas. The essential data for this installation are illustrated in Fig. 5. As shown on Curve No. 1, soil resistivities are unusually low, being less than 250 ohms per cu. cm. at many points and exceeding 1000 ohms per cu. cm. in only one short section. The potentials taken in May, 1941, are shown by Curve No. 2a and similar data for February, 1942, are plotted on Curve No. 2b. It will be noted that the total d-c. current for the 4.8 miles of pipe has been increased from 236.7 to 299.1 amp. from May, 1941, to February, 1942. Similarly, the average density of current drained per sq. ft. of pipe surface exposed for the entire 4.8-mile section has been increased from 2.20 to 2.78 milliamp. Although there have been some corresponding changes in potentials at numerous points, experience here seems to be contrary to usual accepted theories. Curves No. 3a, No. 3b, No. 4a, and No. 4b show unit outputs in amp. and d-c. watts, respectively, for May, 1941, and February, 1942. The total d-c. watts has been increased during this period from 827.6 to 1420.5. Part of this increase in d-c. power is of course due to increases in ground bed resistance. The total a-c. electric peak load on this installation is now about 2900 watts or 605 watts per mile of 16-in. pipe. The total average consumption to date amounted to about 1300 kw-hr. per month, and the overall efficiency including distribution lines, transformers, and rectifiers, is roughly 49 percent.

As shown on the chart in the upper left-hand corner of Fig. 5, the corrosion leaks repaired on this section of

TABLE I

Section of line protected			Cathodic protection requirements				
			A-c. input		D-c. output		
Condition of coating	Outside pipe dia., in.	Pipe length, miles	Total watts	Watts per mile, 2 in. equiv.	Total amp.	Amp. per mile, 3 in. equiv.	Avg. milliamp. per sq. ft. pipe surface
None	8⅝	4.4	2815	222	119	9.4	2.27
None	8⅝	1.2	900	261	60	17.6	4.25
None	8⅝	20.9	8400	140	724.8	12.1	2.41
None	16	4.8	2880	113	299.1	11.7	2.82
None	18	3.1	2600	140	197.1	10.6	2.55
None	8⅝	8.7	3200	128	154.6	6.2	1.51
None	12	1.5	....	....	92.80	15.5	3.73
Poor	14	1.0	230	49.2	29.6	6.34	1.54
Fair	16	10.0	4800	48	331.5	3.3	0.80
Poor	14	10.0	4800	48	331.5	3.3	0.80
Fair	16	3.3	1500	45.45	119.50	3.6	0.87
Poor	14	3.3	1500	45.45	119.50	3.6	0.87
Fair	16	3.0	2700	90	161.7	5.4	1.30
Poor	14	3.0	2700	90	161.7	5.4	1.30
Fair	14, 16, 18	136.0	7000	9	490	0.6	0.14
Good	6	4.4	60	6.8	3	0.3	0.07
Good	4	14.0	150	8	14.4	0.7	0.17
Excellent	4	4.7	25	4	4.0	0.6	0.14
Good	12	29.0	395	3.4	59	0.5	0.12
Good	6	8.5	812	48	51	3.0	0.73

line during the last five years were as follows:

1937	31
1938	51
1939	78
1940	76
1941	43

Allowing about three months for this installation to be effective, it is found that 69 corrosion leaks were repaired in the 12 months prior to May 1, 1941, and only 9 during the following 11 months. Six of the latter 9 leaks were located by the maintenance crews early in October, 1941, shortly after a pressure test, which exceeded previous peak pressures by 78 lb., or 23.5 percent, had been run on the line. Due to other urgent work our maintenance staff was unable to repair those 6 leaks until December, but they are believed to have been caused by increased operating pressure.

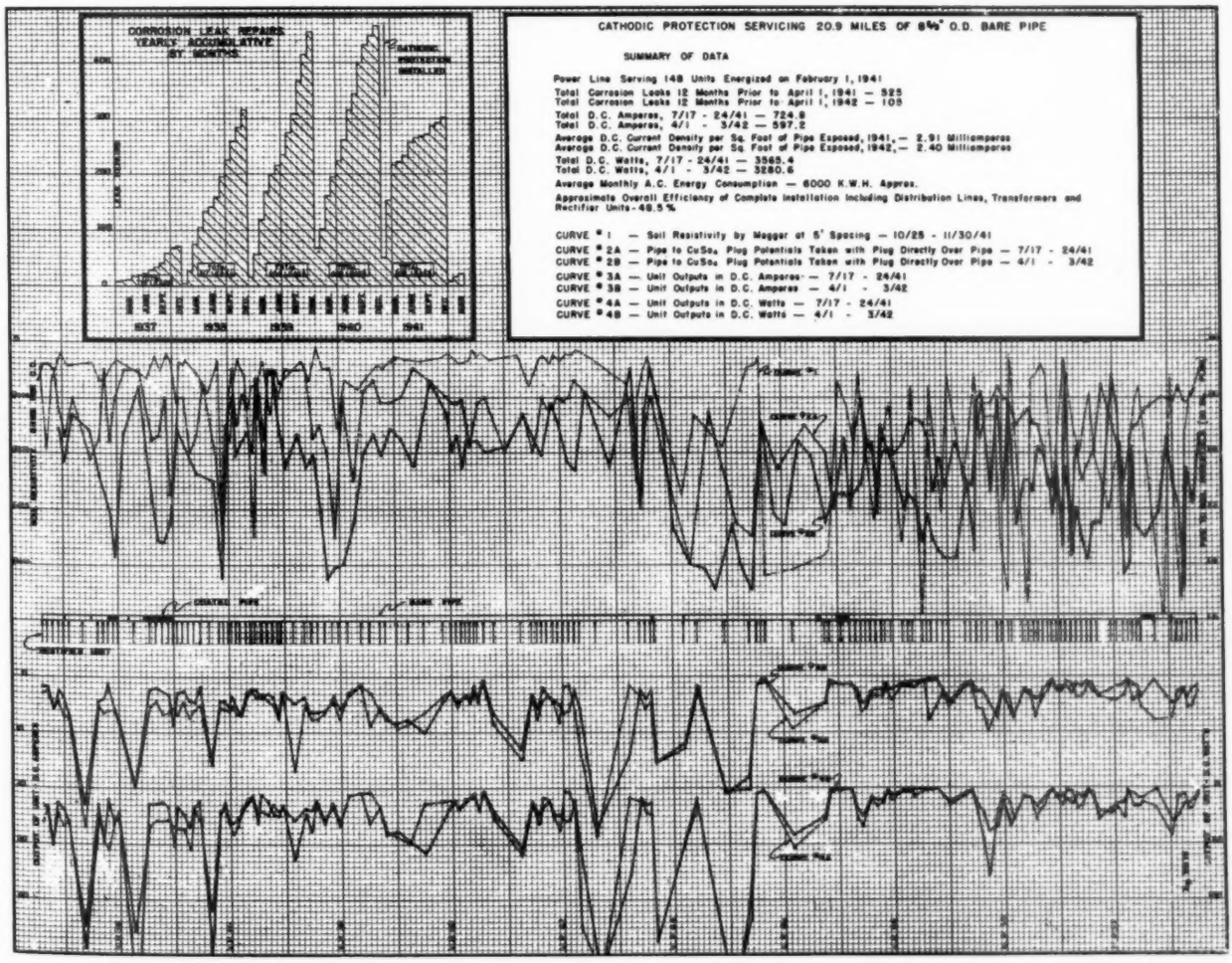
Bare and Poorly Coated Lines

Other installations have been made on bare and poorly-coated lines where 2, 3, and 10 units per mile of right-of-way were used. Unfortunately, with available field data and due to the variations in soil conditions and effectiveness of coatings in limiting current requirements, it is impossible to draw any definite conclusions regarding the relative efficiency of utilizing less than 10 units per mile. Experience has shown, however, that the total installation costs are roughly the same with 10 units per mile as when larger units are used with greater spacing. With larger units, additional rectifier capacity and ground bed material are necessary and the cost of ground bed right-of-way is usually increased. With smaller, closely-spaced units, more rectifier housings, connections, and miscellaneous fittings are required. For installations on large-diameter bare lines, when it is necessary to construct electric distribution lines paralleling the pipe line, small, closely-spaced units appear the more practicable at the present time. On coated lines when the coating is known to have sufficient electrical resistance to limit the current requirements to some extent, fewer units with greater spacing should, of course, be used.

At present, it is known that current densities on bare pipe vary over a wide range exceeding 6 milliamp. per sq. ft. in some sections, and dropping to less than 1 milliamp. per sq. ft. in others with no particular correlation to other available data. From a theoretical standpoint, it is rather disappointing to find that more precise data are not yet available regarding the variations of current density from point-to-point on each section of line under protection. In a practical sense, however, we are primarily interested in average and total current and power requirements. With facilities provided in these designs it is only necessary to predetermine the total d-c. current and power requirements on each section of line proposed for protection in order to estimate the costs with a fair degree of accuracy. The total overall costs of any given installation will seldom be materially affected by the distribution of rectifier capacity.

The tabulation in Table 1 includes average a-c. and d-c. current and power requirements for a number of cathodic protection installations on the system.

Fig. 4


CORROSION LEAK REPAIRS YEARLY ACCUMULATIVE BY MONTHS
CATHODIC PROTECTION INSTALLED
1937
1938
1939
1940
1941
CATHODIC PROTECTION SERVICING 20.9 MILES OF 8⅝" O.D. BARE PIPE
SUMMARY OF DATA
Power Line Serving 148 Units Energized on February 1, 1941
Total Corrosion Leaks 12 Months Prior to April 1, 1941 — 525
Total Corrosion Leaks 12 Months Prior to April 1, 1942 — 105
Total D.C. Amperes, 7/17 - 24/41 — 724.8
Total D.C. Amperes, 4/1 - 3/42 — 597.2
Average D.C. Current Density per Sq. Foot of Pipe Exposed, 1941 — 2.91 Milliamperes
Average D.C. Current Density per Sq. Foot of Pipe Exposed, 1942 — 2.40 Milliamperes
Total D.C. Watts, 7/17 - 24/41 — 3565.4
Total D.C. Watts, 4/1 - 3/42 — 3280.6
Average Monthly A.C. Energy Consumption — 6000 K.W.H. Approx.
Approximate Overall Efficiency of Complete Installation Including Distribution Lines, Transformers and Rectifier Units - 48.5 %
CURVE # 1 — Soil Resistivity by Megger at 5' Spacing — 10/25 - 11/30/41
CURVE # 2A — Pipe to CuSO4 Plug Potentials Taken with Plug Directly Over Pipe — 7/17 - 24/41
CURVE # 2B — Pipe to CuSO4 Plug Potentials Taken with Plug Directly Over Pipe — 4/1 - 3/42
CURVE # 3A — Unit Outputs in D.C. Amperes — 7/17 - 24/41
CURVE # 3B — Unit Outputs in D.C. Amperes — 4/1 - 3/42
CURVE # 4A — Unit Outputs in D.C. Watts — 7/17 - 24/41
CURVE # 4B — Unit Outputs in D.C. Watts — 4/1 - 3/42

Conclusion

It is believed that the designs described in this paper represent a distinct advance in the practical application of cathodic protection to bare pipe lines. Application costs have certainly been reduced to a large degree and flexibility in adjustments to meet actual field conditions increased. It is hoped that the ideas and experiences of others may be combined to effect further improvement in corrosion control by cathodic protection in the near future.

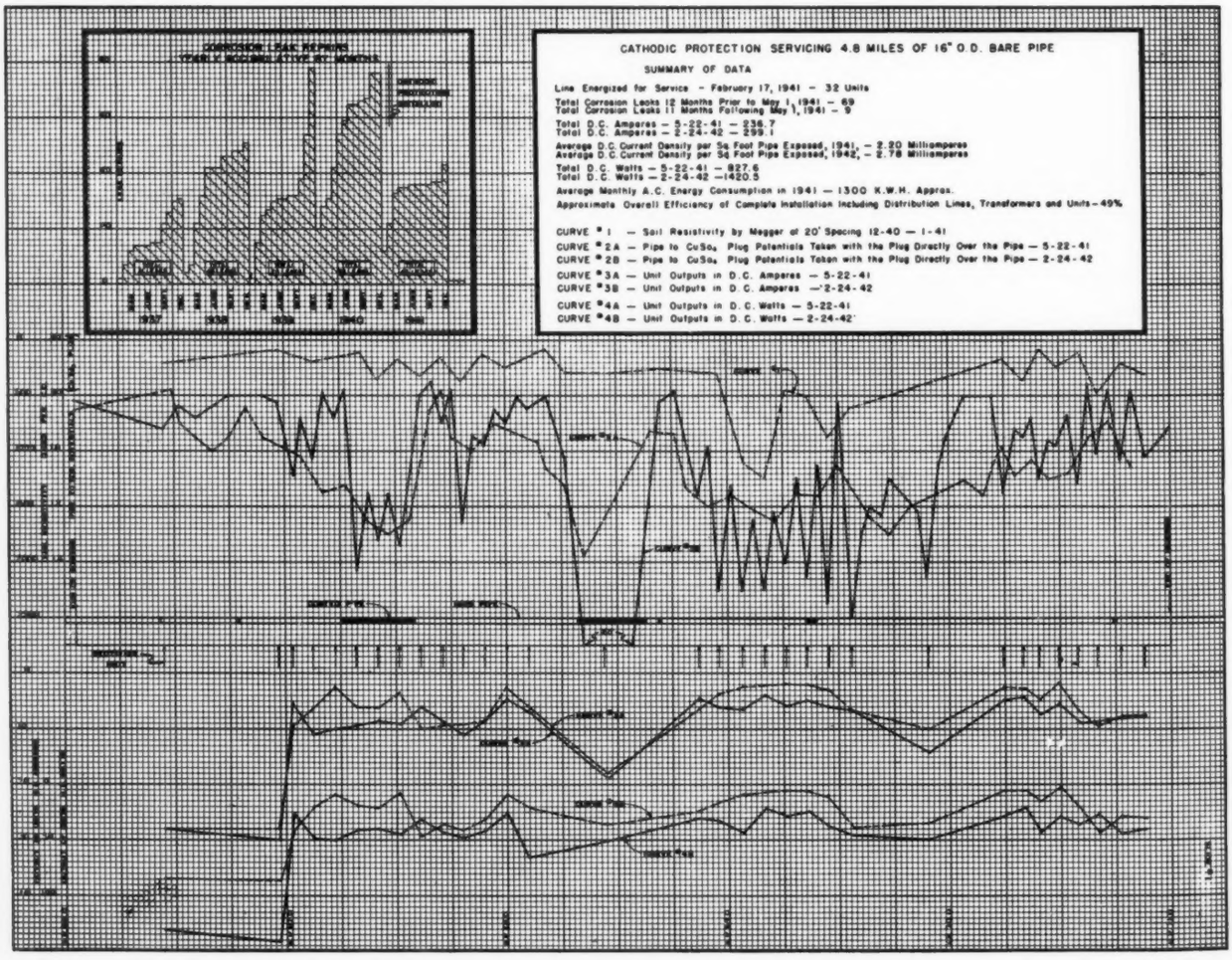
There are numerous ways in which it appears possible that cathodic protection costs can be further reduced in the near future. As ground beds and distribution lines are now the two largest items of cost, however, it is suggested that development effort be concentrated on those problems for the immediate future. In reviewing the history of cathodic protection for the last 10 or 12 years, it is rather startling to note that very little improvement in practical design and installation methods has been made in connection with ground anodes. More recently several laboratory technicians and practical cathodic protection engineers have been investigating possibilities in this phase of the problem. Several non-corroding materials and chemical anodes have been suggested and experimented with to some extent. It is hoped that real practical improvements will materialize very soon, particularly now that junk steel is so urgently needed for war.

In cases where new lines are laid requiring parallel communication circuits, they can perhaps be combined with electric power circuits for cathodic protection. Although the writer has not yet had the opportunity to study this problem in detail, there seems to be no reason why a single- or double-conductor electric distribution line cannot be equipped with the necessary carrier channels for communication and thus eliminate one or more overhead conductors.

In these times everything possible is being done to assist in the war effort by reducing the amount of critical maintenance materials for essential industries so that a maximum amount of war equipment can be made available. In this connection, estimates were recently prepared of the critical metals required for a group of proposed cathodic protection installations as compared with the estimated amount of new pipe steel that would be required during the next five years if corrosion is not brought under control in 1942. This group of proposed jobs included 15 separate installations varying in length from 0.5 to 10 miles and totaling 53 miles of pipe or 256 miles of 3-in. equivalent. This estimate showed that about 28 tons of new steel, 15 tons of copper, and 180 tons of junk steel would be required to complete the cathodic protection installations as proposed. On the other hand, if these installations were not made in 1942, carefully considered estimates show that 467 tons of new pipe steel would be required in 1943, 376 tons in 1944, 552 tons in 1945, 352 tons in 1946, and 249 tons in 1947, for necessary reconditioning and replacement work. The total for the five-year period amounts to 1996 tons as compared with a total of 223 tons of new and junk critical metals required for cathodic protection.

☆☆☆

Fig. 5


CATHODIC PROTECTION SERVICING 4.8 MILES OF 16" O.D. BARE PIPE
SUMMARY OF DATA
Line Energized for Service - February 17, 1941 - 32 Units
Total Corrosion Leaks 12 Months Prior to May 1, 1941 - 69
Total Corrosion Leaks 11 Months Following May 1, 1941 - 9
Total D.C. Amperes - 5-22-41 - 236.7
Total D.C. Amperes - 2-24-42 - 299.1
Average D.C. Current Density per Sq. Foot Pipe Exposed, 1941, - 2.90 Milliamperes
Average D.C. Current Density per Sq. Foot Pipe Exposed, 1942, - 2.78 Milliamperes
Total D.C. Watts - 5-22-41 - 827.6
Total D.C. Watts - 2-24-42 -1420.5
Average Monthly A.C. Energy Consumption in 1941 - 1300 K.W.H. Approx.
Approximate Overall Efficiency of Complete Installation Including Distribution Lines, Transformers and Units - 49%
CURVE #1 - Soil Resistivity by Megger at 20' Spacing 12-40 - 1-41
CURVE #2A - Pipe to CuSo4 Plug Potentials Taken with the Plug Directly Over the Pipe - 5-22-41
CURVE #2B - Pipe to CuSo4 Plug Potentials Taken with the Plug Directly Over the Pipe - 2-24-42
CURVE #3A - Unit Outputs in D.C. Amperes - 5-22-41
CURVE #3B - Unit Outputs in D.C. Amperes - 2-24-42
CURVE #4A - Unit Outputs in D.C. Watts - 5-22-41
CURVE #4B - Unit Outputs in D.C. Watts - 2-24-42

BETTER PERFORMANCE THROUGH

Selective Cementing ★

PLENTY in time . . . not too little too late—that is what today's drilling program means. More important than ever to *select cement to fit the job.* These jobs presented two different problems . . . Lone Star had the right cement for each:

'STARCOR' SELECTED FOR EMERGENCY JOB Rosenberg Field, 180° F. temperature. Unpredictable blow-out and subsequent developments necessitated cementing drill-pipe in hole, a very difficult operation, requiring easy-flowing cement for proper placing. 'Starcor' selected for the job and 570 sacks, slurry weight 16.5 lbs. per gallon, were pumped through drill pipe in 35 minutes; maximum pump pressure 1500 lbs. Strong, dense, trouble-free shut-off.

'INCOR' SELECTED: Hull Silk Pool Field . . . 4292′ of 5½″ OD pipe in 9″ hole; temperature, moderate; 250 sacks 'Incor', slurry weight 16 lbs. per gal., pumped down in 11 min.; 700 lb. max. pump pressure to land plug on float-collar. Early drill-out, well on production quicker.

Use 'Starcor'* for deep wells . . .'Incor'* for moderate-depth wells. For highest temperatures and pressures, use 'Texcor'† —extra slow setting, longer pumpability, high strengths, great density. Lone Star's four oil-field cements meet the entire range of cementing conditions. Select cement to fit the job.

*Reg. U. S. Pat. Off. †Trade Mark

SYMBOL OF QUALITY — LONE STAR CEMENT CORPORATION — EVER SINCE 1900

★ SELECT CEMENT TO FIT THE JOB

'TEXCOR' for deepest wells. Extra slow setting, longer and easier pumpability at highest temperatures . . . higher strengths.

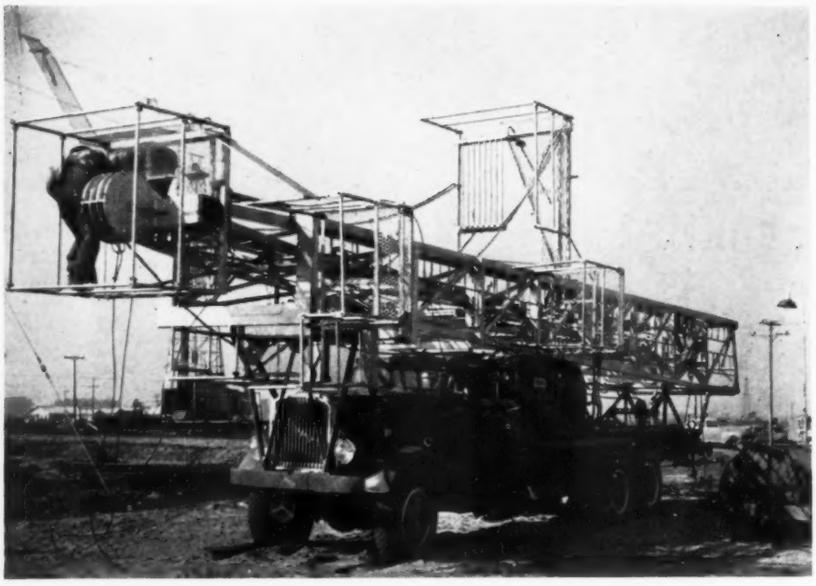
'STARCOR' for deep wells. Slow setting; pumps easily at high temperatures. 6 years' successful performance in deep, hot holes.

'INCOR' for wells of moderate depth. Earlier drill out, wells on production quicker. 15 years' outstanding performance.

LONE STAR for all around use, above ground and elsewhere. Portland Cement of outstanding quality ever since 1900.

LONE STAR CEMENT CORPORATION

DALLAS — 'Starcor' . . . 'Incor' . . . Reg. U. S. Pat. Off. — HOUSTON



A 90-ft. truck-mounted telescoping derrick servicing unit telescoped to 50-ft. length and in place over truck for location-to-location move

PETROLEUM ENGINEER Exclusive Feature

by James Moon
Engineer,
Franks Manufacturing Corporation

Portable Drilling and Servicing Units and Steel Conservation

With steel a vital war material, permanent derricks and attendant equipment over wells are under scrutiny

IT IS estimated that approximately 90,000 tons of new steel derricks were used in 1941 and left standing over the holes of nearly 10,000 wells.

As the demand for steel in war industries increases, it is pertinent to consider what will be the practice of 1942 and 1943?

Slightly more than one-third of the 31,341 wells completed last year were dry holes, holes over which it was unnecessary to leave permanent equipment such as derricks. Of the remaining 20,000 new wells, some were drilled with derricks transferred from other locations and rebuilt at considerable expense; some wooden derricks were used, and some of the wells were drilled with new portable units carrying their own derricks. It is reasonable to assume that this represents another one-third of all wells drilled. This leaves a total of 10,000 new wells that required new derricks last year.

Taking as an average example the 94-ft. servicing derrick, which weighs about 9 tons including crown block, ladders, tubing board, and pulling line, but without substructure, it can be seen that for last year's operations alone some 90,000 tons of steel were left standing over the hole.

It has been estimated that in 1942 it will be necessary to drill at least 30,000 new wells to supply the needs of the nation—and even then some storage withdrawals will be necessary, as was the case in 1941. Some experts place the figure even higher than 30,000 wells.

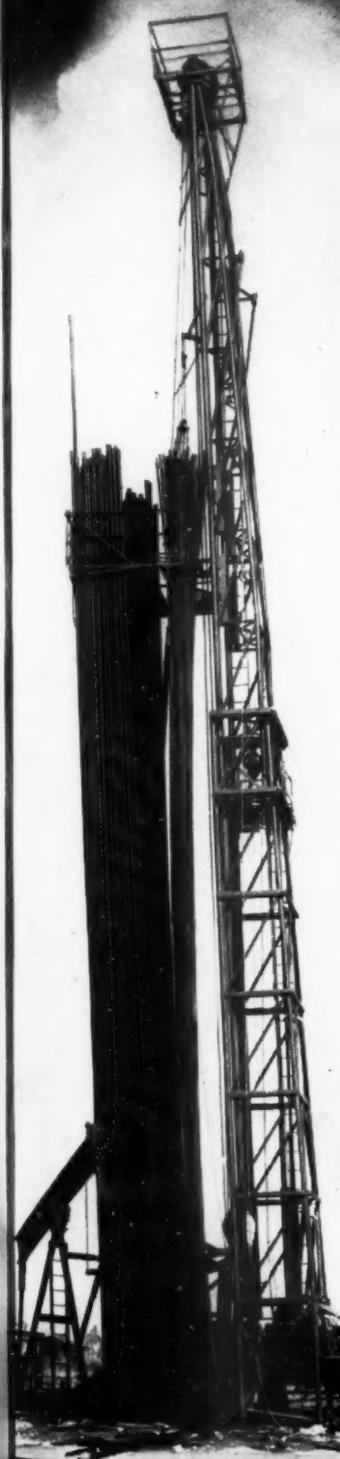
JAMES MOON

was born in Independence, Kansas, and received his elementary education in Wichita—Completed his college work at the University of Wichita, after which he was employed in the drafting and designing departments of major Wichita aircraft firms—Left the Stearman factory in December, 1939, to become design engineer for Franks Manufacturing Corporation in Tulsa, Oklahoma—At present is sales engineer and Franks representative with Hillman-Kelley, Inc., Los Angeles, California.

Where is the steel for new derricks to come from? Will the Government allow enough steel to be diverted from war production for drilling 30,000 wells in 1942, thousands of tons of which, it may be presumed, must be left standing? Probably not, but there is at least a partial solution to the problem. It is known that due to new methods now in use many wells being drilled and others already drilled need not be equipped with permanent derricks.

Several years ago, one major oil company in the Mid-Continent area conceived the idea that if some form of portable derrick could be designed—tall enough to pull range-2 tubing in doubles and hang rods—it would be economically feasible to eliminate permanent servicing derrick structures. After all, permanent derricks are used only a few times a year, the average being less than 1 percent of the time. The rest of the time they stand idle,

4,068 TONS OF ~~DERRICKS~~ *Steel* SAVED BY 8 FRANKS MFG. CORP. WELL SERVICING AND DRILLING UNITS UNITS



Plus

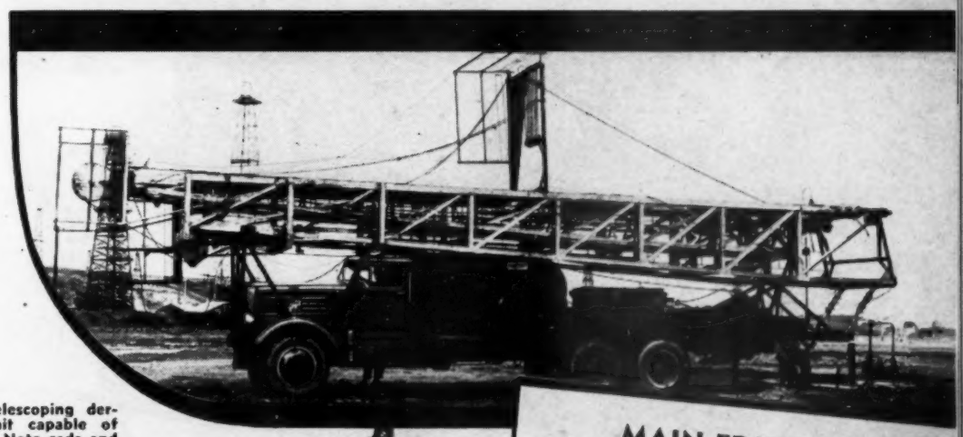
SAVINGS IN RIG-UP, TEAR-DOWN & MOVING

Eight Franks portable servicing units are eliminating 4,068 tons of steel as shown by the following table:

Unit No.	Mounted On	Derricks Each Unit Eliminates*	Tons of Steel Saved
1	Truck	60	540
2	Truck	45	405
3	Truck	75	675
4	Truck	72	648
5	Truck	49	441
6	Truck	51	459
7	Trailer	48	432
8	Truck	52	468
TOTAL	8	452	4068

*Number saved depends on locality.

Besides the value of this saving to our all-out war effort, it can easily be seen the savings afforded operators in derrick cost alone. Additional savings are made by the faster rig-up, tear-down and moving facilities built into Franks units.



Left, Franks telescoping derrick servicing unit capable of 10,000 ft. work. Note rods and tubing stacking facilities. Above shows over-the-road position.

MAIN FEATURES

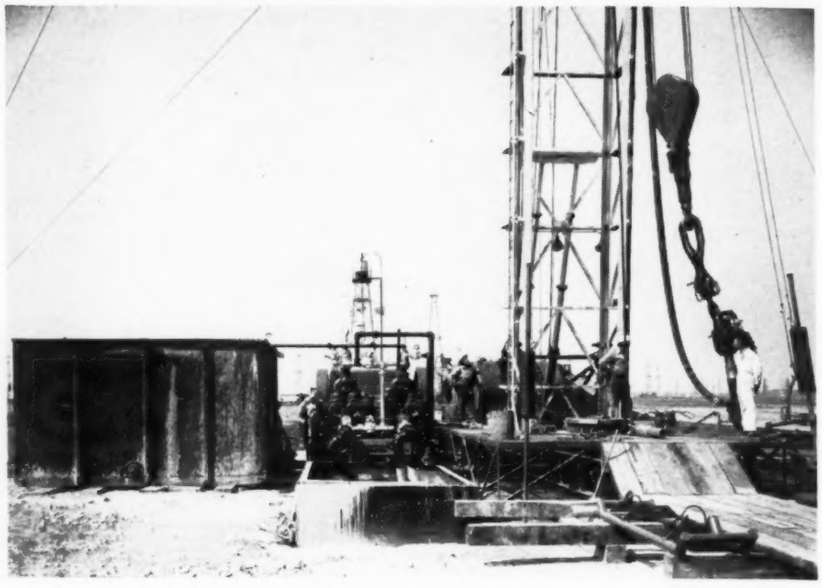
Can be used for "slim-hole" drilling, deepening and cleanout work with rotary attachment; 100 percent portable; derrick raised and lowered in 7 minutes by power screw device; requires only four guys; lines and block remain strung in moving; models for shallow to 10,000 ft. wells.

For Further Details See Franks Representatives

Cable Address: FRANSI

Export Office: A. V. Simonson, 149 Broadway, New York, U. S. A.
Texas, Gulf Coast, Arkansas and New Mexico: R. M. White, Neil P. Anderson Bldg., Fort Worth, Tex.
Oklahoma, Kansas, Rocky Mountains: W. R. Brown, Box 137, Whittier Sta., Tulsa, Okla.
Illinois Basin and Michigan: Glen L. Wigton, Box 26, Vincennes, Ind.
California: Hillman-Kelley, Inc., 2441 Hunter Street, Los Angeles, Calif.

FRANKS MFG. CORP.
WELL SERVICING AND DRILLING UNITS
TULSA, OKLAHOMA



Portable telescoping trailer-mounted derrick drilling in California

and thus "tie-up" thousands of dollars in steel and capital.

On the basis of this idea, a portable 84-ft. telescoping derrick was designed in 1938, and was so successful in use that it was followed soon thereafter by other designs in different heights and capacities. Now, after several years, there is a wide variety of portable derricks, both for drilling and servicing. They are mounted on truck, trailer, or skids. Their adoption has led to the reduction or elimination of the permanent derrick, thus effecting a large economic saving for the oil industry.

Until 1941, the prime consideration in the use of portable derricks was economic. As the nation neared war, and finally became engaged in war, the urgency and critical necessity of steel in the war effort soon became apparent, even to the exclusion of its immediate use for the production of oil. Steel was to be conserved—to be used wisely and sparingly. In the conservation of steel, therefore, portable derricks combined with portable servicing and drilling units can play an important role.

Consider the permanent equipment usually left at each well. Aside from the pumping equipment, if any, we will find a derrick, either wooden or steel, and varying in height from 60 to 136 ft. If the wells in any particular area are giving the average amount of trouble, a permanent crown block arrangement will likely be left in each derrick; also, to eliminate the time required for "stringing up," a pulling line may be left in the derrick. Further, we may find that each derrick is equipped with a tubing platform for racking tubing, a safety ladder with offset platforms and guard railings, and in many cases electric lighting equipment of the explosion-proof type. It is estimated that in the case of steel derricks a modest average of at least 18,000 lb. of steel per derrick is left at each well. It should be remembered also that usually this is galvanized steel and quite often an alloy.

Steel derricks may be left over the well because of the cost and inconvenience of tear-down and re-erection. To the oil industry and the nation at war, they represent a large amount of steel. For every 100 derricks over wells that have to be serviced occasionally, there are also 100 crown blocks, 100 pulling lines, 100 ladders, offset platforms, and guard railings, 100 tubing boards, and 100 separate explosion-proof lighting systems. One or two

The top section of this portable derrick may be removed, or the entire derrick may be folded down over the truck for short location-to-location moves

PETROLEUM ENGINEER EDITION

BAASH ROSS News

BAASH-ROSS TOOL COMPANY, LOS ANGELES, HOUSTON, NEW YORK

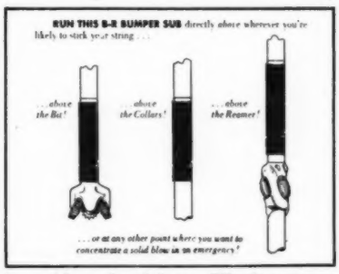
A BULLETIN COVERING NEWS OF EQUIPMENT AND OPERATIONS IN THE PETROLEUM INDUSTRY

DRILL *Safely!* TWO IMPORTANT NEW B-R TOOLS TO SAFEGUARD YOUR DRILL STRING

The Baash-Ross Drilling Type Bumper Sub

When you're working in sticky formations, key seats—or any place apt to bind your drill pipe so it's necessary to *jar* loose, here's the tool to place in your string!

With this new Drilling Type Bumper Sub, you can deliver either a *downward* or an *upward* blow by a simple straight raising or lowering of the drill string . . . and without making adjustments or changes of any kind in the tool. You can jar up ▲ and if that doesn't free you, you can jar down. ▼ Or you can alternate up and down jarring, if desired—all by simple drill pipe manipulation!


RUN THIS B-R BUMPER SUB directly above wherever you're likely to stick your string . . .
. . . above the Bit!
. . . above the Collars!
. . . above the Reamer!
. . . or at any other point where you want to concentrate a solid blow in an emergency!

HERE'S ALL THERE IS TO IT

To jar *down*, first raise the drill pipe and drop or "spring" it the full length of the Bumper Sub stroke (usually 16 inches). This gives a solid downward blow, the force of which is easily controlled by the way in which the drill string is handled!

For an *upward* blow, simply take a moderate stretch in the pipe, then drop the string suddenly until the Sub is partly open. The pipe rebound causes a hard, hammer-like blow to be struck *upward* against the top of the Sub. In most cases, a few solid blows are all that are necessary to completely loosen the drill string!

REPLACEABLE SPLINES

It goes without saying that a Bumper Sub has to stand a lot of punishment in a drill string . . . taking the pounding torque loads of driving the bit . . . constant battering against the hole . . . twisting surges during rough drilling . . . and, at the same time, preventing leakage of the circulating fluid. That's why Baash-Ross has built *extra* ruggedness and strength into this sub—to insure *longer life, lower maintenance* on the toughest kind of drilling jobs!

The heavy body has longitudinal splines cut in the inside surface, into which fits a correspondingly splined mandrel. These two parts are free to move *longitudinally*, but cannot *rotate* with respect to one another because of their interlocking splines. This Sub not only has more splined area, but in addition, has *replaceable* bronze spline inserts which can be quickly and economically changed when worn. That's why it stands up under the toughest drilling without breakdown. What's more, a large diameter washpipe, effectively packed off from *both inside and outside* the string, enables you to maintain high pressure circulation day after day without danger of leakage!

FOR REGULAR AND F. H. PIPE

The Baash-Ross Drilling Type Bumper Sub is built of carefully selected alloy steels, correctly heat-treated for maximum strength. *It will stand any force—in either direction—that the drill string is capable of delivering* . . . and is available in both right and left hand types, in all popular drill pipe sizes—both regular *and full hole*. So, regardless of the size or type drill string you're using, if you're drilling in sticky formations, safeguard that string with a B-R Drilling Type Bumper Sub. It's the most economical protection you can buy. Ask your nearest Baash-Ross representative for complete details . . . or write direct!

(Leased in U.S.A.—Sold for export only)

DOUBLE VALUE

Both the Drilling Type Bumper Sub and the Type "E" Safety Joint can be used in fishing operations, too. That means *double* value, *double* efficiency—for the tool you buy to safeguard your drill string can also be used interchangeably on whatever fishing operations may come along—*an important economy point!*

Baash-Ross Type "E" Autolock Safety Joint

For Drilling Strings

When you're drilling in formations that may cave or heave, the chances are slim against your jarring your way out. So your best chance of saving your string is to *unscrew* it . . . and here's the tool to run—the **Type "E" Autolock Safety Joint!**

This new Baash-Ross development is timed to the minute for modern high-speed deep-drilling operations. It can be used at any point in the drill string . . . is made to rotate in an unscrewing direction without danger of accidental release . . . yet it unscrews quickly and easily *at the will of the operator!*

HOW THIS JOINT IS BEING USED

Operators who have already used this Safety Joint have found a number of important applications for it in their drilling operations.

▶ One spot is a short distance *above* the point where formations have a tendency to cave or heave. When using it this way, of course, the Joint should be placed a sufficient distance above the danger spot so that it will still be in the clear when the full amount of hole has been made before coming out again to change bits. That is, if you plan to make 150 feet of hole before coming out to change bits, the Joint should be placed say 175 feet or more above the danger spot . . . enough to keep the Joint in the clear at all times without leaving too much pipe below the joint to be recovered in an emergency.

▶ A considerable number of operators—particularly those making lots of hole each trip—are using *two* Joints to insure complete safety as well as minimum pipe loss. They place one Joint a short distance above the danger zone, the other a considerable distance above so that it will be in the clear at all times. Then, regardless of whether the pipe sticks just after running in a new bit or near completion of the run, they can always obtain maximum recovery!

▶ Another important application is in drilling-out operations. Here, the Joint is located in the string so that it will always be in the casing *above the shoe*. Then should the pipe stick in open hole, loss is reduced to an absolute minimum.

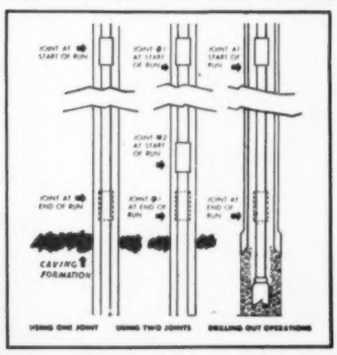
RUGGED — SIMPLE — DEPENDABLE

The Baash-Ross Type "E" Joint has been built to meet the requirements of the most severe drilling service. A glance at the illustration will show you its simple rugged construction . . . similar to that of the famous Baash-Ross Type "C" Joint for fishing. However, unlike the single shoulder of the "C," the Type "E" incorporates a series of driving shoulders all the way around the circumference, providing *extra* driving area to meet heavy torque loads without tightening.

In addition, the locking shoulders are so designed that when the Joint is made up, they will mate in only the correct position. This eliminates the possibility of overtightening or "freezing" the Joint and insures quick, positive release whenever desired. Packers prevent fluid leakage while drilling and are so designed that SIX unscrewing turns can be effected *without losing the fluid seal*.

SAFE, POSITIVE RELEASE

The Type "E" permits reverse rotation, when necessary, under normal conditions, as the reverse torque is transmitted through the heavy, spring-loaded collar and tapered shoulders. Yet, when release is desired, it requires not more than *half* the torque needed to break a normally made-up tool joint of the same size!



The Type "E" Autolock Joint is stronger than the drill pipe on which it is run—and will safely transmit all driving torques. So when drilling in heaving or caving formations make sure your drill string carries this newest safeguard to cut your pipe losses, increase your drilling safety. Available in all popular pipe sizes from Baash-Ross headquarters in your territory.

(Leased in U.S.A.—Sold for export only)

WITH PIPE AT A PREMIUM, THESE TWO NEW DEVELOPMENTS ADD VITAL PROTECTION

Stuck pipe has always been a costly, troublesome problem in drilling. But now, with pipe so difficult to get and with the cost of putting down a hole increasing every day, it is even *more* important that you take *every* precaution possible to protect your wells against stuck drill pipe . . . and against the expensive fishing operations that follow.

Here are two new Baash-Ross safety tools that give you the protection you need. When run on your regular drilling string, one enables you to *jar* your way out of a dangerous situation . . . the other to *unscrew* your way out. Each has its particular advantages. Read about them . . .

portable servicing units carrying their own self-raising and lowering derricks may alone provide adequate equipment for efficiently servicing each of these 100 wells.

Types of Portable Derricks

Of the several types of portable derricks now on the market, one of the popular types is designed for servicing wells to 11,000 ft. and has a 90-ft., two-piece telescoping derrick, mounted either on truck or trailer, which is usually built especially for the hoist and derrick installation to make a complete well-servicing or drilling machine. This complete machine includes drawworks, hoist, transportation, derrick, engine, crown block, raising mechanism, electrical equipment and line, and in some cases a rotary drive attachment. The machines travel with blocks strung and carrying their own guy lines.

Moving the equipment into position, raising, locking, and guying the derrick requires from 30 minutes to an hour, a figure comparable to that required to move into a regular permanent derrick with a portable hoist and tie onto the pulling line or string the sand line. Raising the portable derrick is done by the power supplied and built into the equipment, and requires no help from outside sources. The blocks are left permanently strung and the guy wires remain attached.

Further to decrease the usefulness of this type of equipment, it is available with a rotary drive attachment, making it suitable for exploratory drilling, for shallow production drilling, for medium depth "slim hole" drilling, for deepening, clean-out, and for following up big rotaries. These units are also used for all servicing operations in connection with the repair and maintenance of oil wells. The rods are hung and the tubing is stacked in a manner similar to that in regular derricks.

Usefulness of Units

A typical example of the usefulness of these units is the experience of a drilling contractor in Texas, who in one year with one of these rigs, worked on 58 wells, including 16 cleanouts, 11 deepenings, 10 rotary follow-ups, and 21 jobs of running tubing. Moves in excess of 100 miles and rig-up the same day were not unusual.

Another example of the use of a truck-mounted servicing machine is reported from California where one of these units moved from Santa Maria to Ventura in a driving time of six hours, moved onto a small mountainside location after negotiating a curving mountain road, and, with an inexperienced crew, pulled 8475 ft. of 3-in. tubing in seven hours and ran it back in slightly less than five hours.

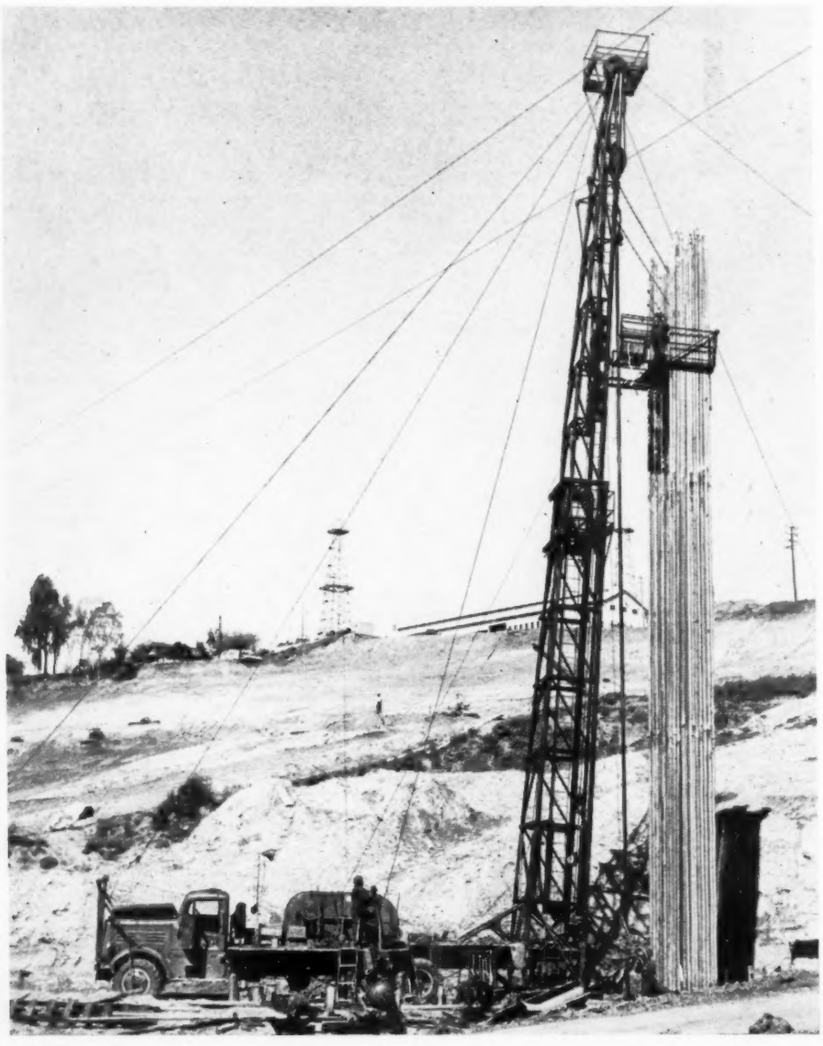
Still another example is a trailer-mounted machine being used for both drilling and servicing. In slightly less than one year it has drilled 16 wells (2000-ft. average depth), redrilled two others, and is being used to service 28 wells without derricks that range in depth from 9,000 to 11,500 ft. During the year it made seven long moves, two being more than 100 miles.

Of more than a dozen of these rigs in use in California, it is estimated that nine of them will result in a saving of 4482 tons of steel, or an average of 500 tons of steel for each portable derrick and hoist unit. Each portable derrick is complete within itself, eliminating the necessity of duplicating valuable equipment other than derricks at each well.

Each portable derrick unit can be used for many purposes, ranging from exploratory drilling to the servicing, maintenance, and repair of oil wells.

There are a few limiting factors in the use of these portable units. They have not as yet been used successfully for deep drilling, although they are being used to service wells to 11,000 ft. They have proved to be economically sound for drilling to average depths, which last year in the United States was between 3000 and 4000 ft. They have moved into almost inaccessible locations on bad mountain roads, although it is recognized that there are some locations very difficult of access. On the basis of average figures and experience, it can be stated that the use of portable drilling and servicing derricks can aid greatly in the conservation of steel by the oil industry not only now but also during the post-war period.

☆ ☆ ☆



Truck-mounted servicing unit pulling tubing in well at Ventura, California. The deepest well pulled by this unit to date is 9788 ft.

A. P. I. Eastern District Meeting Pittsburgh

↑ *Standing (left to right): F. A. Christanelli, Baroid Sales Division, National Lead Company, Houston, Texas; W. W. Mayfield, Hope Natural Gas Company, Clarksburg, West Virginia; Furniss Prell, Hughes Tool Company, Clay City, Illinois; D. Sikes, Baroid Sales Division, Tulsa, Oklahoma; E. H. Tollefson, Hope Natural Gas Company, Clarksburg; R. Griffin DeLaMater, Parkersburg Rig and Reel Company, Parkersburg, West Virginia; G. C. MacDonald, Gulf Oil Corporation, Tulsa; R. E. Damp, Carter Oil Company, Mattoon, Illinois; C. W. Alcorn, Falcon-Seaboard Drilling Company, Houston; W. E. Ferguson, The Ohio Fuel Gas Company, Columbus, Ohio; J. V. Goodman, Equitable Gas Company, Pittsburgh, Pennsylvania. Sitting (left to right): V. F. Bowyer, Peoples Natural Gas Company, Pittsburgh; M. G. Gulley, Gulf Oil Corporation, Pittsburgh; R. B. Anderson, Columbian Carbon Company, Charleston, West Virginia; J. J. Schmidt, East Ohio Gas Company, Cleveland, Ohio; and Amos Roberts, Baroid Sales Division, Olney, Illinois*

↑ *New officers Eastern District of A.P.I.: Sitting (left to right): M. G. Gulley, chairman, Gulf Oil Corporation, Pittsburgh; R. B. Anderson, vice-chairman, Columbian Carbon Company, Charleston, West Virginia; Standing (left to right): V. F. Bowyer, vice-chairman, The Peoples Natural Gas Company, Pittsburgh; R. E. Damp, vice-chairman, Carter Oil Company, Mattoon, Illinois; W. E. Ferguson, vice-chairman, Ohio Fuel Gas Company, Columbus, Ohio; and J. V. Goodman, secretary-treasurer, Equitable Gas Company, Pittsburgh. C. C. Irby, vice-chairman, Turner Petroleum Corporation, Mt. Pleasant Michigan, is not in the picture*

↑ *O. W. Van Petten (left), retiring chairman, Columbian Carbon Company, Charleston, West Virginia, and R. E. Damp, Carter Oil Company, Mattoon, Illinois, get together for a private discussion*

↓ *All smiles are R. E. Damp (left), Carter Oil Company, Mattoon, Illinois; W. W. Mayfield, Hope Natural Gas Company, Clarksburg, West Virginia; E. H. Tollefson, Hope Natural Gas Company, Clarksburg, and Furniss Prell, Hughes Tool Company, Clay City, Illinois*

Engaging in this back-slapping session are M. G. Gulley (left), Gulf Oil Corporation, Pittsburgh; R. E. Damp, Carter Oil Company, Mattoon, Illinois; O. W. Van Petten, Columbian Carbon Company, Charleston, West Virginia; E. H. Tollefson, Hope Natural Gas Company, Clarksburg, West Virginia, and D. Sikes, Baroid Sales Division, Tulsa ↓

A. P. I. Mid-Continent District Meeting Tulsa

↑ *H. M. Stalcup, vice-president, Skelly Oil Company, Tulsa, who presided at one of the afternoon sessions*

L. S. Allen (left), National Tank Company, Tulsa, and G. F. Isley, Shell Oil Company, Wichita Falls, Texas

R. G. Ralph (left), Kobe, Incorporated, Oklahoma City; T. M. White, engineer, Phillips Petroleum Company, Bartlesville; F. J. Pisarra, attorney, Phillips Petroleum Company, Bartlesville; J. S. Montgomery, general superintendent of northern region, Phillips Petroleum Company, Bartlesville, and C. L. White, superintendent, Phillips Petroleum Company, South Burbank Unit, Fairfax, Oklahoma

↑ *E. O. Bennett, Continental Oil Company, Ponca City, Oklahoma*

↑ *M. J. Kirwan (left), Cities Service Oil Company, Bartlesville, Oklahoma; C. E. Beecher, Cities Service Oil Company, Bartlesville, and J. R. McWilliams, Carter Oil Company, Tulsa*

R. J. Woods, Jr. (left), district sales manager, Jones and Laughlin Steel Corporation, Tulsa; Bill Timberlake, Continental Supply Company, Tulsa, and Glenn M. Stearns, University of Oklahoma, Norman, Oklahoma

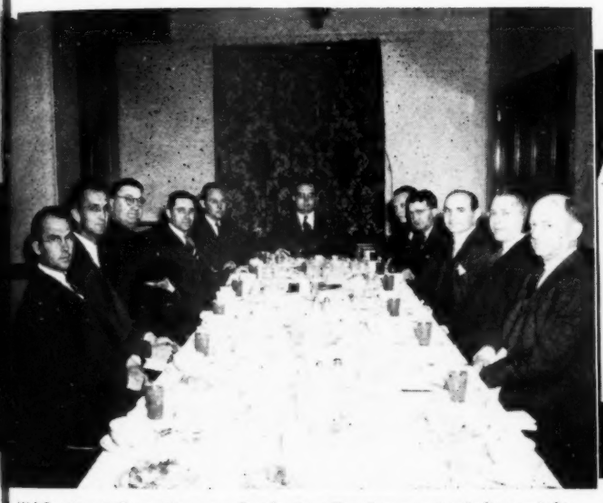
↓ *H. H. Elliston, Sinclair Prairie Oil Company, Tulsa, discussing salt water disposal systems*

D. A. Sikes (left), Mid-Continent sales manager, Tulsa, Harold H. Farnham, Gulf Coast sales manager, Houston, Texas, and Fred Christanelli, Houston, all of Baroid Sales Division, National Lead Company; H. W. Ladd, superintendent of materials, Stanolind Oil and Gas Company, Tulsa, and Geo. L. Ratcliffe, general manager, Baroid Sales Division, Los Angeles, California

Among the new officers elected at the meeting are Herbert Goodpaster, chairman (left), Kerlyn Oil Company, Oklahoma City; R. P. Moscrip, vice-chairman, Shell Oil Company, Inc., Wichita, Kansas, and H. F. Beardmore, secretary-treasurer, Amerada Petroleum Corporation, Tulsa

J. E. McFate (left), Republic Steel Corporation, Tulsa; A. E. Butts, A. O. Smith Corporation, Tulsa, and J. H. Brooks, Republic Supply Company, Tulsa

A. J. Edwards (left), Black Sivalls and Bryson, Tulsa; F. R. Wheeler, Barnsdall Oil Company, Tulsa; M. M. Kinley, Houston, and H. B. Hodges, Mid-Union Drilling Company, Tulsa



Mid-Continent Committee on Production Practice meets. Left to right: Eugene Hosford, Gulf Oil Corporation, Tulsa; Glenn Stearns, University of Oklahoma, Norman; C. A. Young, American Petroleum Institute, Dallas; H. Dave Collins, Four States Oil Company, Tulsa; Herbert F. Beardmore, Amerada Petroleum Corporation, Tulsa; J. S. Montgomery, Phillips Petroleum Company, Bartlesville; F. M. Stevenson, Phillips Petroleum Company, Oklahoma City; F. R. Wheeler, Barnsdall Oil Company, Tulsa; J. A. McCutchin, British American Oil Producing Company, Tulsa; I. S. Salnikov, Carter Oil Company, Tulsa, and C. V. Millikan, Amerada Petroleum Corporation, Tulsa

D. R. Knowlton, Director of Production, Office of Petroleum Coordinator, Washington, D. C., addressing the assembly

Albert Geiger (left), Deep Rock Oil Corporation, Tulsa; C. O. Moss, Deep Rock Oil Corporation, Tulsa; Wm. H. Rouzer, Jr., K.M.A. Pressure Maintenance Association, Wichita Falls, Texas, and H. K. Browning, Kobe, Incorporated, Oklahoma City

Wirt Franklin, Director in Charge of Production, District No. 2, Office of Petroleum Coordinator, Chicago, was one of the speakers

H. M. Ryder (left), Ryder Scott Company, Bradford, Pennsylvania, and C. R. Horn, assistant professor of petroleum engineering, Texas Technological College, Lubbock, Texas

L. F. McCollum, President, Carter Oil Company, Tulsa, addressing the gathering

O. E. Berg (left), Bethlehem Steel Company, Houston; H. G. Texter, Spang Chalfant, Inc., Ambridge, Pennsylvania; W. J. Crites, Phillips Petroleum Company, Bartlesville; H. M. Cooley, Bethlehem Steel Company, Tulsa, and R. P. Moscrip, Shell Oil Company, Inc., Wichita, Kansas

Natural Gasoline Association of America Meets in Tulsa

RAY E. MILLER, *President*

J. R. JARVIS, *Vice-President*

J. W. VAIDEN, *Vice-President*

WM. F. LOWE, *Sec'y-Treasurer*

H. H. BEESON, *Vice-President and Chairman of the Technical Committee*

H. L. ODER, *Chairman, gave the report of the Gas Testing Committee*

H. A. MONTGOMERY *presented a paper on "Elimination of Errors in Fractional Distillation of Gases"*

D. L. KATZ *gave a paper on "A Suggested Standard Method for the Measurement of High-Pressure Gases"*

E. O. BENNETT, *Chairman, High Pressure Gas Division, Technical Committee. Winner of 1942 Hanlon Award*

R. A. CARTER, *member of the Program Committee*

B. R. CARNEY *delivered paper on "The Density of the L.P.G. Hydrocarbons, Their Mixtures, and Three Natural Gasolines"*

S. F. MAUNEY, JR., *member of the Program Committee*

Locating Cased-off Productive Zones

PETROLEUM ENGINEER Exclusive Feature

☆ **Radioactivity logging aids in economical recovery of oil and conservation of steel by disclosing prospective oil production behind casing**

by Wallace A. Sawdon

Pacific Coast and Foreign Editor

THERE is a considerable amount of cased-off oil in the various fields of the United States. As lower zones become depleted probably all this oil that is economically recoverable can be made available for use without the introduction of new casing into the well and with little or no new equipment of any kind. The economy of the recompletion work, however, will depend on how readily the prospective zones can be located. Much of this cased-off oil in California is of the heavier grade that is particularly needed at this time, and its recovery with the minimum expenditure of steel is most desirable. Sufficient, reliable subsurface data have been collected during the drilling of many of the more recently completed wells that will facilitate the location of prospective zones, but there is a far greater number of older wells with cased-off production for which such data are not available. The use of radioactivity logging has aided greatly, however, not only in locating the sands behind the casing in many of the old wells but also in confirming and correcting the subsurface data in the newer wells before work-over jobs were begun.

Some wells now reaching the economic limit in their present producing zones were drilled with cable tools and some with rotary. Upper zones were cased-off either unknowingly or because better production could be obtained at greater depth. Some of this upper production lies behind three or four strings of casing and in some wells behind five strings of casing. At the time many of the wells were drilled adequate subsurface records were not kept, coring was inadequate, and little or no attention was paid to keeping the hole vertical.

In fields where upper production was known to exist or was later discovered, many of the older wells have been recompleted in the upper sands as the lower zones became depleted. Such work-over jobs have necessarily been done in the past by hit-or-miss methods. Dipping structures, faults, and crooked holes have added to the difficulties in locating the prospective sands and errors as great as several hundred feet have occurred. In many instances the work required a long series of gun-perforating, testing, and squeeze-off operations before production was found. In some wells production believed to exist behind the casing has not been obtained, probably because the proper location was never determined.

Radioactivity Logging

The chief use of radioactivity logging in the California fields has therefore been to determine the location of sands behind casing and thus aid in obtaining production known to be existent in upper zones previously cased-off. Although the greatest number of radioactivity logs have been taken in wells where the records are incomplete or unreliable, many logs have been taken in recently drilled wells to verify subsurface information or to confine recompletion operations to a more limited distance in the well, particularly when water may be known to lie close to the oil-bearing stratum. The radioactivity logs taken in old wells have also provided general geological information that can be correlated with that procured during the drilling of later wells, but logging for that purpose alone has possibly not yet been done.

Radioactivity logging provides a means of logging through casing by running a highly sensitive detector into the well on a conductor cable to measure the gamma rays that enter the hole from the contiguous formation. These rays, originating in the formation, pass through the casing and cement or other material occupying the annulus between the casing and the wall of the hole and thus identify by means of their relative measurements the character of the formations behind the casing. The intensity of the rays is naturally decreased by the steel of the casing and by surrounding cement or other matter. It has been found that this dampening effect of the steel is approximately four times that of the mass usually found between the casing and the wall of the hole. This resistance, however, remains a fixed constant in each particular well during logging operations and does not affect the number of rays emanating from the formation. Radioactivity measurements have been taken through as many as five strings of cemented casing and there are clear indications on the record when the instrument passes from or into the shoe of a string, depending on whether the run is being made down or up.

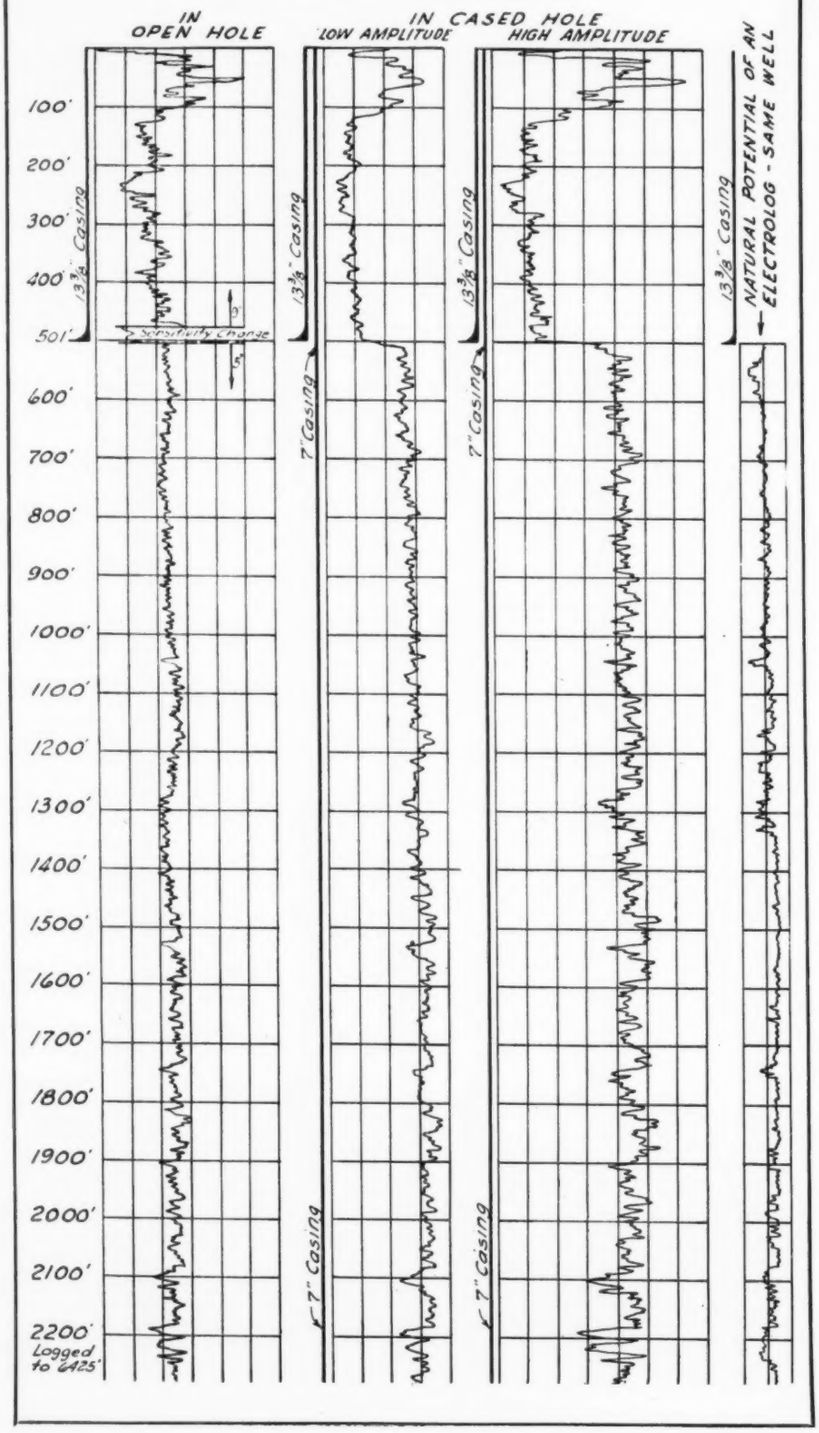
Nature of Equipment

The instrument inserted into the well consists of an ionization chamber above, which is an amplifier. An ionization current produced in the chamber by the gamma rays is amplified and transmitted up the conductor cable to recording equipment at the surface, where it is further amplified to actuate an automatic pen recorder. The record is made on a paper chart that moves in synchronism with the travel of the instrument as it is moved upward or downward in the hole; and as the detector passes a formation the radioactivity of that formation is traced on the chart. This provides a continuous depth log that shows the relative radioactivities of the strata lying behind the

one or more strings of casing with which the hole is cased, as shown in the accompanying illustrations.

The strength of the ionization current is proportional to the number of gamma rays passing through the chamber per second. As the resistance to passage of the rays varies with the number and thickness of casing strings and also because the general intensity of radioactivity in different areas is not the same, the sensitivity of the equipment is adjusted to meet the conditions encountered. The sensitivity established for the down-hole conditions is maintained for the run so that variations in gamma ray measurements are related to the same base. Increases in radioactivity cause the trace to move to the right and decreases cause it to move to the left. Shales and sands possess different radioactivities and the character of the formation thus disclosed by the log provides a means for selection of zones behind the casing to be tested. Logs are taken regardless of the kind of fluid or the presence or lack of fluid in the well.

Fig. 1. Radioactivity logs of same well



Use in Cased and Open Hole

Radioactivity logs were taken in both open and cased hole of a well recently drilled in the Los Angeles Basin in order to study the effect of casing on the curves and to compare the curves taken in both open and cased hole with those of an electrical log. The logs of the upper portion of the well are shown in Fig. 1. All radioactivity logs were begun at the surface but the electrical log was naturally begun at the shoe of the 13⅜-in. surface string, which had been cemented at 501 ft. Only the natural potential of the electrical log is reproduced, as it serves adequately for comparison.

The sensitivity of the radioactivity log in open hole was reduced drastically before going out of the surface string and the portion actually in open hole was taken with an amplitude much lower than that of the low amplitude log made of the hole after it was cased. After this log and the electrical log were taken, the hole was cased with 7-in. and the two radioactivity logs with different amplitudes were then run.

The effect of the surface pipe is evident in both the low- and high-amplitude logs and the location of the shoe is clearly indicated. Inaccuracies in casing records have thus frequently been discovered. As was to be expected, the high-amplitude log gives a sharper definition of minor changes in the character of the formations. As the sensitivity can be controlled, the requirements of the job can readily be met and resistance offered by multiple strings of casing provided for.

Interpretation of Log

As is the case with similar subsurface records, the interpretation of the radioactivity log is of vital importance. In fields where electrical logs have been taken in nearby wells that have been drilled recently, the general stratigraphical data supplied by the electrical log will facilitate the interpretation of the radioactivity log of an old well. When the radioactive log is taken in a well for which an electrical log is available, a comparison of the two logs assists in making a close determination of the limits of the prospective zone.

★

For Outstanding Achievements in the Production of Naval Ordnance

It is our great honor to have received the coveted "E"—the highest award the U. S. Navy can make for Excellence in production efforts.

We have supplied ordnance material to the Navy for many years. During the first World War we tripled our production. Recently we have tripled it again.

We are indebted to the many customers who, in times of peace, helped us keep our facilities ready for great national emergencies. In a very real sense they have contributed to the honor of the "E".

THE HARRISBURG STEEL CORPORATION

HARRISBURG, PENNSYLVANIA

HARRISBURG PRODUCTS . . . Alloy and Carbon Steels . . . Seamless Steel Cylinders, Pipe Couplings . . . Pump Liners, Liquefiers . . . Hollow and Drop Forgings . . . Pipe Flanges . . . Bull Plugs . . . Aerial Bombs . . . Coils and Bends

★ ★

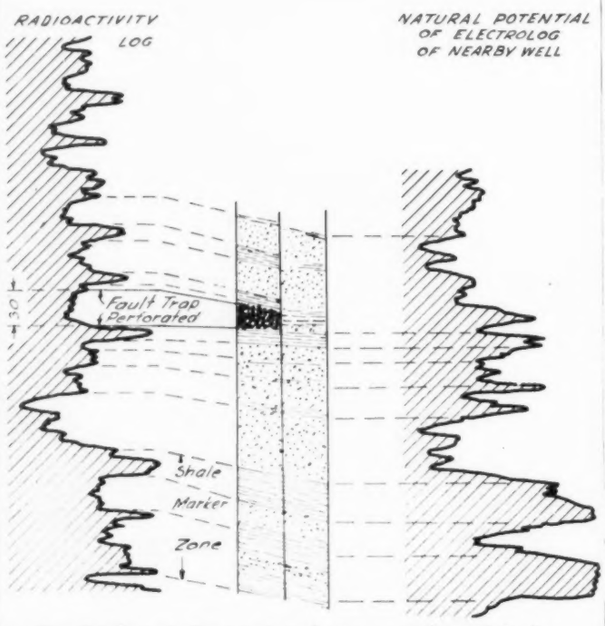


Fig. 2 (above). Comparison between radioactivity log and electrical log of a nearby well

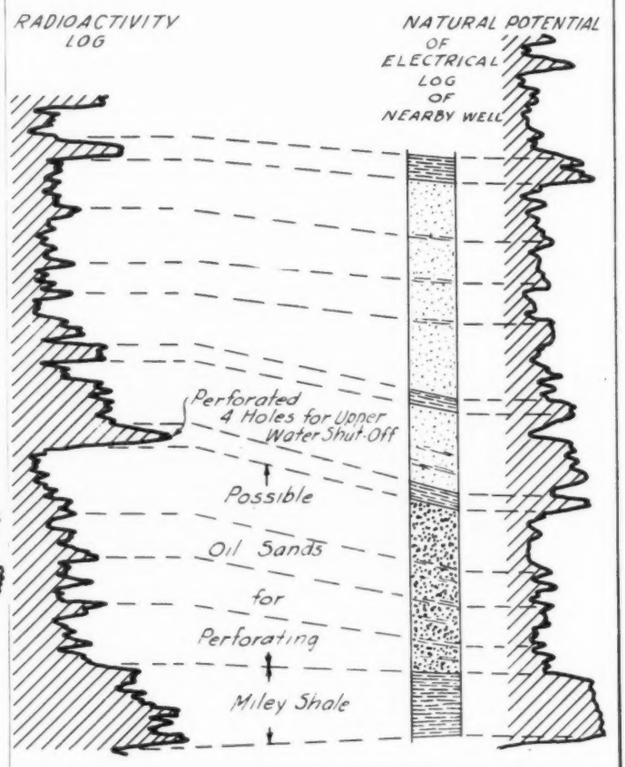

RADIOACTIVITY LOG
NATURAL POTENTIAL OF ELECTRICAL LOG OF NEARBY WELL
Perforated 4 Holes for Upper Water Shut-Off
Possible Oil Sands for Perforating
Miley Shale

Fig. 3 (right). Log taken of well in Coastal Area of California

In most of the fields of California the shales are decidedly more highly radioactive than the sands and the decrease in radioactivity shown by the trace on the chart clearly indicates the sand beds. In a few areas in the San Joaquin Valley the radioactivity of certain formations does not appear to conform to the conventional and logs taken in these areas are more difficult to interpret.

Applications

With proper interpretation the radioactivity log has been utilized to meet some unusual requirements. In a well in the Coastal District of California it was desired to locate a fault trap. This well had been drilled to 7260 ft. before electrical logging came into use, and no correlation information was available. As the producing interval was small and was underlain by wet sands, it was necessary to locate the fault to the nearest foot. The radioactivity log shown in Fig. 2 was taken and the necessary information obtained. A distance of 30 ft. was gun-perforated as indicated and a production of 500 bbl. per day, cutting 3 percent, was obtained. The production previous to the work-over job had been 45 bbl. per day, cutting 70 percent.

In Fig. 2 a comparison between the radioactivity log and an electrical log of a nearby well is shown. The formation column is a combination for the two wells, due allowance being made for the difference in structural elevation. The temperature gradient of the field indicated that the bottom-hole temperature would be approximately 180°F. and the actual temperature measured was 173°F.

In another old well recently recompleted in a coastal field farther north it was known that some prospective sands had been cased-off and that there was a shale bed above the sands where a water shut-off could be made by gun-perforating and squeezing. (See Fig 3.) Before perforating, however, it was decided to check the subsurface data with a radioactivity log as there are local unconformities in various parts of the field and electrical logs of nearby wells may be misleading at certain depths. This log showed the shale approximately 50 ft. higher than indicated by other records and thus prevented perforating too low.

In plug-back operations it is, of course, necessary to have assurance that productive upper zones exist in a given area. In the Long Beach field, for example, there are two cased-off zones known to be productive in certain areas and wet in others. A portion of another zone that is cased-off in some wells is also known to carry clean oil. In other areas portions of still another zone can be profitably produced if located accurately. Most of the wells in which these zones are cased-off are old holes that were drilled with undue speed in order to reach the main producing zone. No attention was paid to maintaining vertical hole at the time the wells were drilled and very few surveys have been made to determine their actual course below the surface. Sharp dips and numerous faults add to the difficuty of locating the prospective zones lying behind one or more strings of casing.

The radioactivity log has been used to advantage in this field to locate zones behind as many as four strings of casing. The log has sometimes been taken to determine the limits of a specific zone and at other times to provide a complete correlation of the entire well. In fields of this kind where numerous radioactivity logs have been taken and many electrical logs are available from adjacent wells recently drilled, the interpretation of radioactivity logs run in cased holes is comparatively simple.

☆☆☆

. . . With Your Ideas on Ways to
SPEED PRODUCTION *with* COMPRESSED AIR

Here's how you can contribute IDEAS to help win the war.

DO THIS: Describe some application of compressed air which speeds production (in your own experience or observation). The IDEA counts—not the grammar. Simple rules mailed on request.

YOUR OPPORTUNITY to pass along ideas which will speed up production and help win the war. Substantial cash prizes offered. Prize-winning papers will be brought to attention of your industry, giving recognition and prestige to the authors. All entries of value to the war effort, whether they are prize-winners or not, will be offered to the proper United States Agency with full credit to the writer.

PRIZES DOUBLED. Because of increased importance of compressed air in the war effort, prize awards as originally announced, have been doubled, and closing date has been extended to July 1, 1942.

ATTENTION EXECUTIVES. Posters announcing this IDEA Award Program are available to enable you to bring this project to the attention of your engineers and shop men. Free on request.

All requests for Rules and Posters should be addressed to Russell Gross, Educational Director, Compressed Air Institute, East Orange, New Jersey.

★ ★ ★ ★ ★ ★ ★ ★

$1000.00 IN CASH AWARDS

FIRST PRIZE $200.00 — THREE PRIZES OF $100.00

TEN PRIZES OF $50.00 — SPECIAL AWARDS $25.00 EACH

For every non-prize winning entry which is accepted for publication in a technical journal, at the request of the Compressed Air Institute.

plus

PERSONAL PRESTIGE and RECOGNITION

Uncle Sam Needs Your Ideas

HERE'S HOW YOU CAN HELP

Describe compressed air applications in your own experience or observation, which speed up production. The IDEA will be passed along to help the war effort. Write today for details.

This announcement appears here through the courtesy of

CLARK BROS. COMPANY • OLEAN, N. Y. • Member of:

COMPRESSED AIR INSTITUTE..

90 WEST STREET NEW YORK, N.Y.

Packer Tester Reduces Workover Time and Labor

PETROLEUM ENGINEER Exclusive Feature

☆ Testing device to assure proper setting of packer can be employed either at well site or in maintenance yard

FAILURE of packers to set tightly when run in wells is due to several causes, and the harmful results of these failures are many. On some occasions packers set before a formation is acidized have resulted in the acid being forced up the annulus past the packer, accumulating on top of the packer rubber. When the formation was cleaned and the well placed on production, the tubing string was eventually eaten in two by the acid, necessitating an expensive fishing job and in some instances resulting in ruined casing plus the cost of labor.

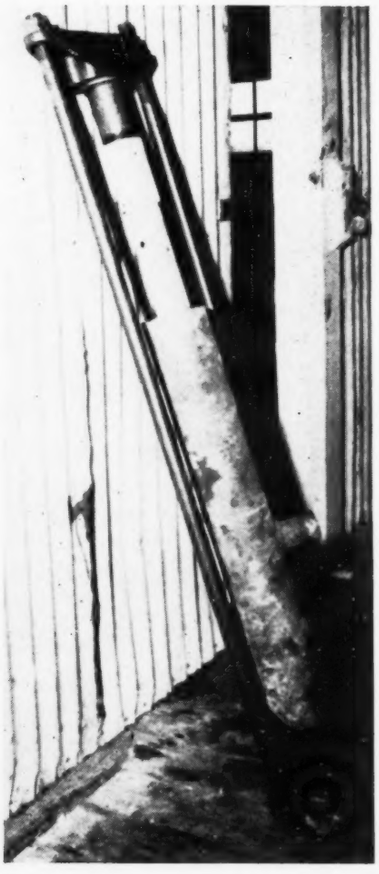
Recently J. D. Baker, production superintendent for the F. H. E. Oil Company in the East Texas field, installed a new packer in a well after a general workover job and found that the packer had failed to set. Pulling the tubing string and removing the packer, it was found that the rubber had cracked longitudinally, indicating that the packer had not been able to compress sufficiently to spread the rubber against the casing wall and thus to seal tightly. A second packer was run and the job completed satisfactorily.

Baker then devised the packer tester shown in the accompanying illustration in an effort to discover what had prevented the packer from setting properly. A swage and nipple were welded to one end of a piece of 5-in. O.D. casing long enough to cover the packer rubber. Below the packer rubber a connection was welded to the section of casing. To test a packer, the equipment is inserted in the casing section, heavy clamps tightened on the swage nipple and a second nipple on the upper end of the packer. Tightening the clamp applies sufficient pressure to set the packer. After the packer has been set, pressure from a pump may be applied through the connection welded below the packer rubber. Pressures as high as 3000 lb. have been used in testing packers.

As a result of testing packers before running in the well, savings in workover time and labor have been effected.

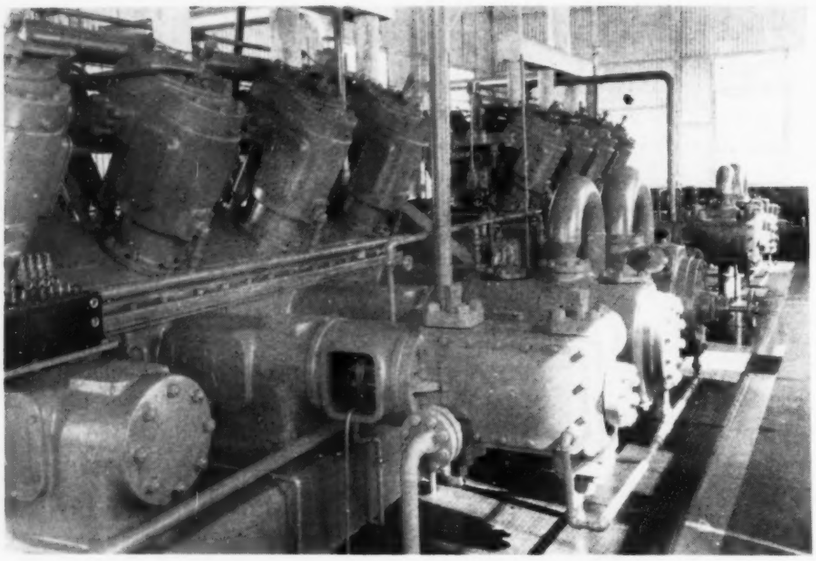
Right—Location of welded nipple on casing section may be seen. Test pressures are applied at this point below the packer rubber

Below—View showing packer inserted in casing section ready for clamps to be tightened



—— ☆ ☆ ☆ ——

KOBE



Compression end of compressor units. Note all piping possible is carried below floor level. Exhaust manifold is waterjacketed and exhaust stacks are shrouded. Gauge boards showing all pressures, for each unit separately, are mounted on wall to right but not shown in picture. Automatic air vent on soft water system can be seen on far engine. It rises above and from line passing under exhaust shroud. Manual air vent for compressor cooling water was also required and installed

PETROLEUM ENGINEER Exclusive Feature

Engineering Study Determines Advisability Of Pressure-Maintenance Installation

☆ Plant constructed in North Novice field, Texas, after well tests reveal feasibility of pressure maintenance as a conservation measure

*by J. Daviss Collett, Jr.**
Consulting Engineer

THE North Novice field lies about 18 miles northwest of Coleman, Texas. The discovery well, drilled in November, 1939, by States Oil Corporation, was completed in the Gardner sand, a member of the Strawn series. In April, 1940, McKissick drilled the Morris No. 1, now States-Robertson, Morris No. 5, about three-quarters of a mile northeast. When the well was satisfactorily completed in the same sand, a rather rapid development began that in April, 1941, had resulted in 26 completions. At present there are 38 wells.

In April, 1941, operators in the field decided to have an engineering study made to determine the advisability of pressure maintenance in the field. As a result of the study, a plant was built and began operating in November, 1941. This discussion covers the history of the field from the beginning until April, 1942, or during development, plant construction, and the first five months of plant operation and gas injection into the producing zones.

The producing sand in North Novice is relatively tight, of low permeability, and irregular, and most of the wells have been shot in order to obtain potentials high enough to satisfy normal operating requirements. Immediately southwest of the field is the older Novice field, which produces from the same sand and under pressure maintenance. The success of this operation indicated that North Novice might also benefit from return of gas to the reservoir. Novice production, which had been declining rapidly, has remained quite constant since operations were placed on a gas-return basis.

J. DAVISS COLLETT, JR.

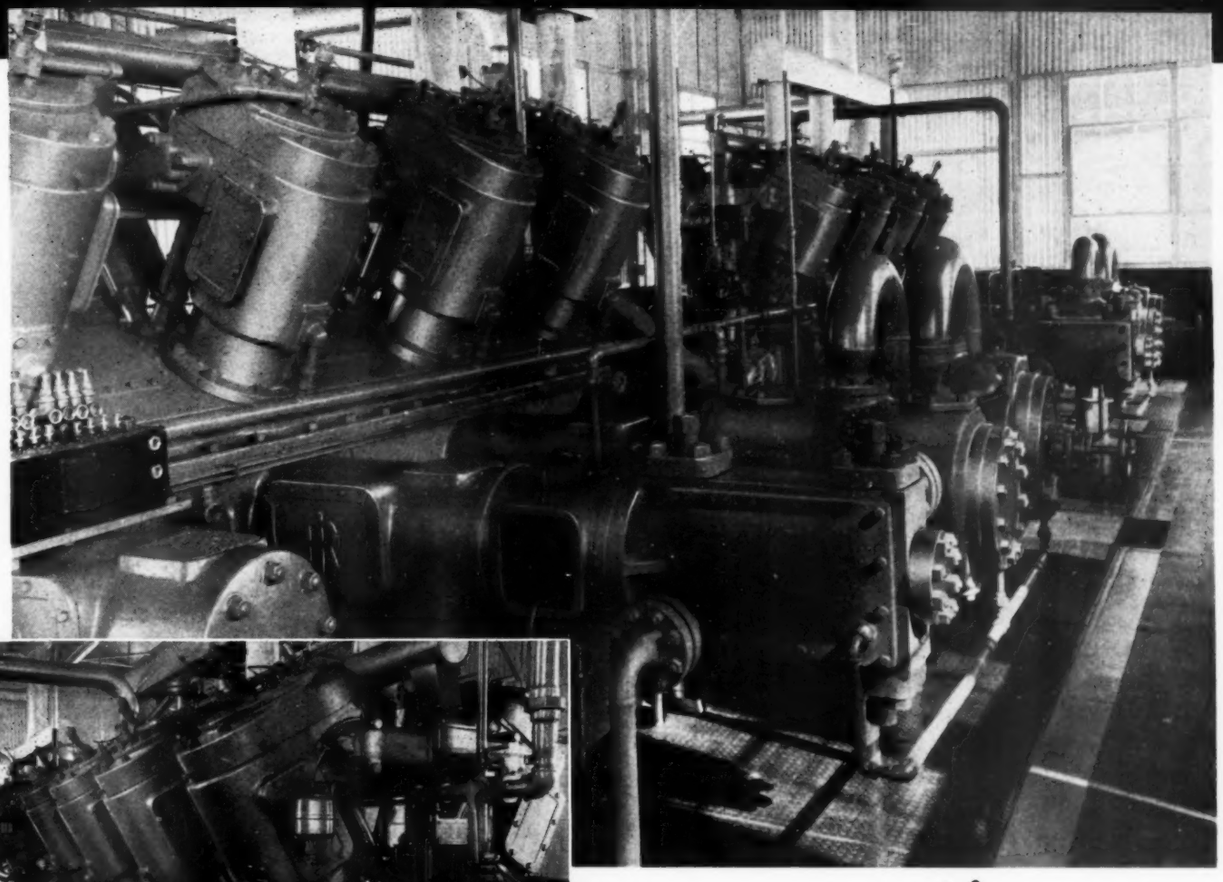
is a consulting engineer of Houston, Texas—Prior to entering consulting work in 1937, he was for five years with the Atlantic Refining Company—In 1938 he organized The Associated Engineers, a petroleum engineering service company of Houston, Fort Worth, and Lake Charles—He continues his private consulting practice at the same time directing activities of The Associated Engineers.

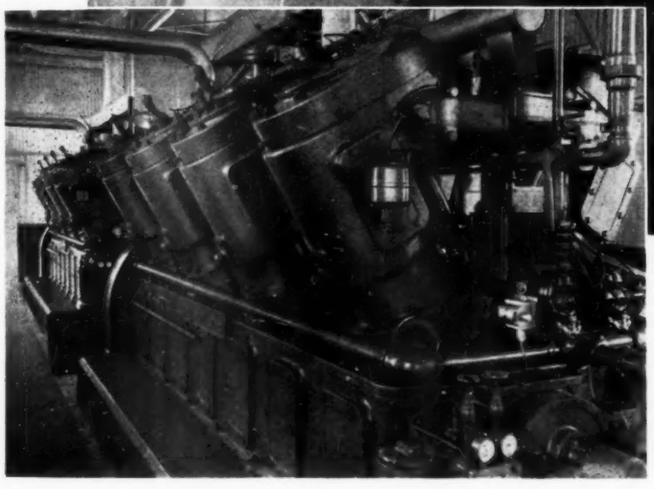
Well Tests

Despite the fact that the sand was irregular, permeabilities averaging about 200, and with most of the wells having been shot so that control of the gas underground was impossible, a study of the area was begun in April, 1941. Some bottom-hole pressures had been run earlier, so the first work constituted running a complete static bottom-hole pressure survey on each well. This survey showed a relatively uniform drainage pattern had been established. This is shown by the isobaric map dated April 1, 1941. The map also shows a lack of efficient water drive. Table 1 shows all pressures run to date. The table reveals the excessive loss in pressure that was taking place

*This article was prepared by Mr. Collett in collaboration with engineers of The Associated Engineers.

REPRESSURING at STATES OIL CORP.





with

XVG

4-CYCLE GAS-DRIVEN COMPRESSORS

The States Oil Corporation had good reasons for selecting XVG Compressors for their new outstanding repressuring plant in the Novice Field, Coleman County, Texas. They knew of the excellent performance record set up by the XVG's in all parts of the world in all types of field and refinery service.

At the States Oil Corporation plant are:—

* *Two 8-XVG 3-stage, gas-engine-driven compressors rated 10-lb per sq in gauge intake (separator pressure in the field) and 1200-lb discharge. Compressor cylinders are fitted with clearance pockets to provide for varying the capacity and keeping the load constant when pressure conditions change.*

* *The air-starting compressor is an Ingersoll-Rand — a gasoline-engine-driven Type 30 with automatic-stop control.*

The XVG was the first V-angle gas-engine compressor unit . . . introduced in 1931. It is built in 75- to 300-hp sizes. Larger and similar 4-cycle units are available up to 800 hp. Gas engines using the same power-end designs range from 185 to 800 hp. Other I-R oil-field equipment includes Pipeline Pumps, Diesels, Pneumatic Tools, and all kinds of Compressors.

Ingersoll-Rand

11 BROADWAY, NEW YORK, N.Y.

and the urgent need for gas conservation.

It was determined that with a uniform drainage pattern it should be possible to control the gas returned to the reservoir by careful studies of bottom-hole pressures and gas-oil ratios. All wells were therefore tested for gas-oil ratios and producing rates. While this testing was in progress, bottom-hole pressures were again run on each of the wells during the potential test to establish the productivity index of most of the wells in the field.

These data were desirable for two purposes. First, it was necessary to know that the wells were capable of producing sufficient oil to meet allowables assigned and yet have bottom-hole pressures that were high enough to prevent too much gas from coming out of solution. It was also necessary to know what effect increased allowables would have on those wells that would be affected by reallocation of allowables from wells used for injection. The second factor was the need of index data, in order to determine the pressures that would be required to inject the gas being produced by all the wells under normal producing rates. The well index data were then used to calculate, for the wells chosen for injection, the pressure required to inject all the gas produced in the area affected by the well. This can be done either graphically with straight-line curves or by direct calculation.

TABLE I

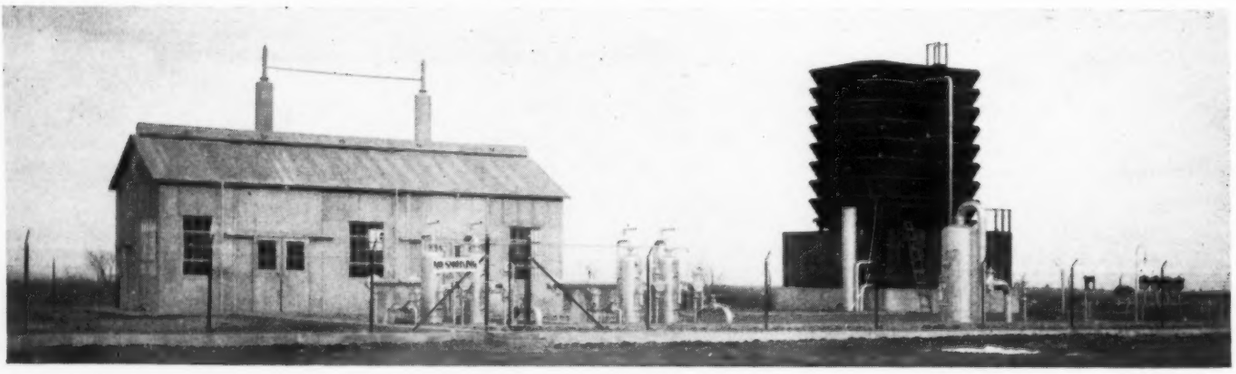
Bottom-hole pressures at 1600 ft., North Novice field, Texas

Lease	Well	BHP 9–25–40	BHP 4–1–41	BHP 7–15–41	BHP 10–27–41	BHP 3–15–42
		Injection begun 11-1-41				
States Oil Corporation						
Coker	1		1170		1080	880
	2		1087		819	759
	3		1103			799
	4		1089			
	5			1015	733	730
	6			1173	1178	978
Morris	1		1212	1201	1062	866
	2		1204		1036	868
	3		1172		972	814
	4		1084		793	728
	5		1144		803	744
	6		1166		837	820
	7		961			
	8		1179		970	857
	9				971	811
	10					841
	11				1251	1092
	12				683	725
States-Robertson						
Gillespie	1	1272	1050			678
	2	1239	1050			680
	3	1033	1034			
	4		1102		758	722
Morris	1	1186	1093			
	2	1236	1112			763
	3	1285	957			1008
	4		1119			715
	5		1128			
	6		1133		895	758
	7		1107		870	740
	8		1147		938	792
	9			1142		1033
	10			857		
	11				1234	921
Owens	1		1287		1263	1169
McKissick						
Morris	1					900

Selection of Injection Wells

The injection wells were selected on a combination of three bases. Low-pressures areas, high gas-oil ratios, and structural positions were the controlling factors. It was believed that low-pressure areas needed pressure assistance to prevent gas from being drawn out of solution and to prevent pumping. High gas-oil ratio areas created abnormal pressure drops and the migration of oil into dry portions of the sand. High structural positions were selected to take the fullest advantage of any water drive that might develop. Four key wells were chosen on this basis, and the maximum pressure required was thereby determined as 1500 lb. In the Novice field some trouble had been experienced with injection pressures. These would increase after gas had been returned for relatively short periods. In order to be sure that injection pressures were not increasing and to determine the extent of such increases if they did occur, the well index curves were again used in conjunction with the static pressure distribution map. With these data the volume that each well would receive, the injection pressure, and the effect of further pressure drops throughout the field before the plant would be completed were all considered and the initial conditions set-up and the effects calculated. In this manner each injec-

Plant site not yet graded and filled. Auxiliary house to left not shown. Intercoolers and scrubbers in foreground. No cooling or scrubbing used after high-stage compression. This reduces freezing trouble near plant and when the gas is reduced at injection meters shown at right. Soft water surge tank shown to left of tower with overflow into tower. Two lines rising beside it are soft water lines. Bypass regulator is shown just to right of field scrubber, which is between camera and cooling tower. Vacuum regulator to prevent vacuum on gathering lines also shown at scrubber. Fuel taken on downstream side so engines will shut down if line pressure drops below 5 lb. Plant master, injection meters, and injection control chokes at far right. Note explosion heads and risers to left of each door



BETTER be SAFE than SORRY

USE GUIBERSON PACKERS IN ALL WELLS NOW

If your well surface connections should be destroyed by enemy action or other causes — a GUIBERSON Packer installed in the well will —

1. Shut off the annular space between tubing and casing and prevent the well from flowing wild through the casing. (To render control of the well complete, in event of such emergency, flow can be prevented through tubing also, by installing automatic shut-off device in bottom of tubing.)
2. Prevent well from catching on fire.
3. Prevent tubing from dropping and being damaged.

The famous GUIBERSON H3R, C-1, and KV30 Packers not only will protect your wells in the ways described, but these packers will be found the most efficient and dependable yet developed for every application for which packers are required.

TYPE H3R PACKER

The GUIBERSON Type "H3R" is the ideal production packer. Ease in setting and pulling from well, full recovery of rubbers without damage, fluid by-pass when pulling, dovetailed slips and seamless steel mandrel of upset diameter, enable this packer to handle toughest well applications.

Packing rubber design is radically different. Consists of three packing rings of oil resisting compound, the end rings having molded-in steel bushings and hairpin reinforcing wires. Excellent for wells of any depth or in wells where differential pressures reach 6,000 lbs. per sq. in.

TYPE C-1 PACKER

GUIBERSON "Control Head" Packers are the most efficient all-purpose packers yet developed. Type "C-1" has 3" vertical valve opening and is a single-rubber packer. Packing medium is a long-lived, highly oil-resisting compound which will not disintegrate or stick to pipe.

Control-head feature is most valuable for running in flowing wells, in wells having heavy fluid, for testing purposes when tubing is plugged, and for acidizing purposes. Valve can be opened, or packer reset higher or lower at any time, by simple manipulation of tubing from surface.

TYPE KV30 PACKER

The GUIBERSON Type KV30 Packer is a tremendously tough and sturdy super-packer of our control-head type, developed to overcome a number of familiar packer troubles. Among its outstanding feaures are (1) its dual-type control-head valve, offering both a metal-to-metal ground seat and a composition valve sleeve, either of which would give a leak-proof seal; (2) its internally reinforced packing sleeve, assuring complete recovery even after being subjected to pressures of 6,000 lbs. per sq. in.; (3) its extra-sturdy anchoring device, with two massive 1¼" gudgeons.

Type KV30, here shown, has 30" valve lift. Type KV8 has 8" valve lift. Type K has no control valve.

For Further Information see GUIBERSON Section, 1942 Composite Catalog

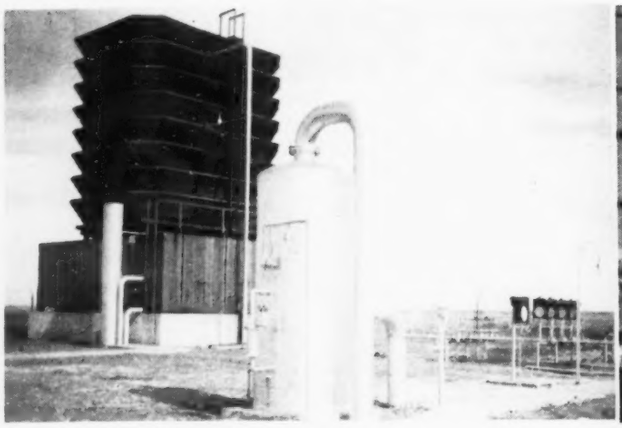
THE GUIBERSON CORPORATION, DALLAS, TEXAS

Representatives in All Important Oil Fields in the United States

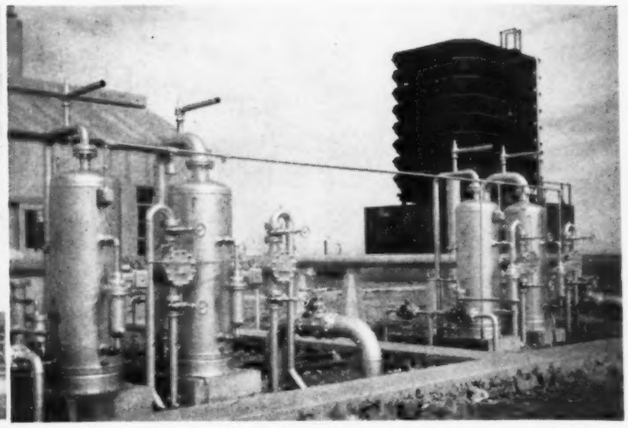
California Distributor:
W. R. Guiberson Co., Los Angeles, Calif.

BETTER BE SAFE THAN SORRY — GUIBERSON

Export Representative:
I. Frank Brown, 30 Rockefeller Plaza, N. Y.



Two Mercoid controls are required on field scrubber, one for each engine. Bypass regulator is shown with discharge into field suction line. Discharge header is immediately under regulator. Vacuum regulator is behind scrubber discharge line and is not visible. Master meter on suction, four discharge meters, and downstream block valves can be seen. Expansion loop on injection line is visible above lefthand block valve. Two raw water bypasses are required as high volume pumps are used one at base of tower just above concrete basin and other half way up



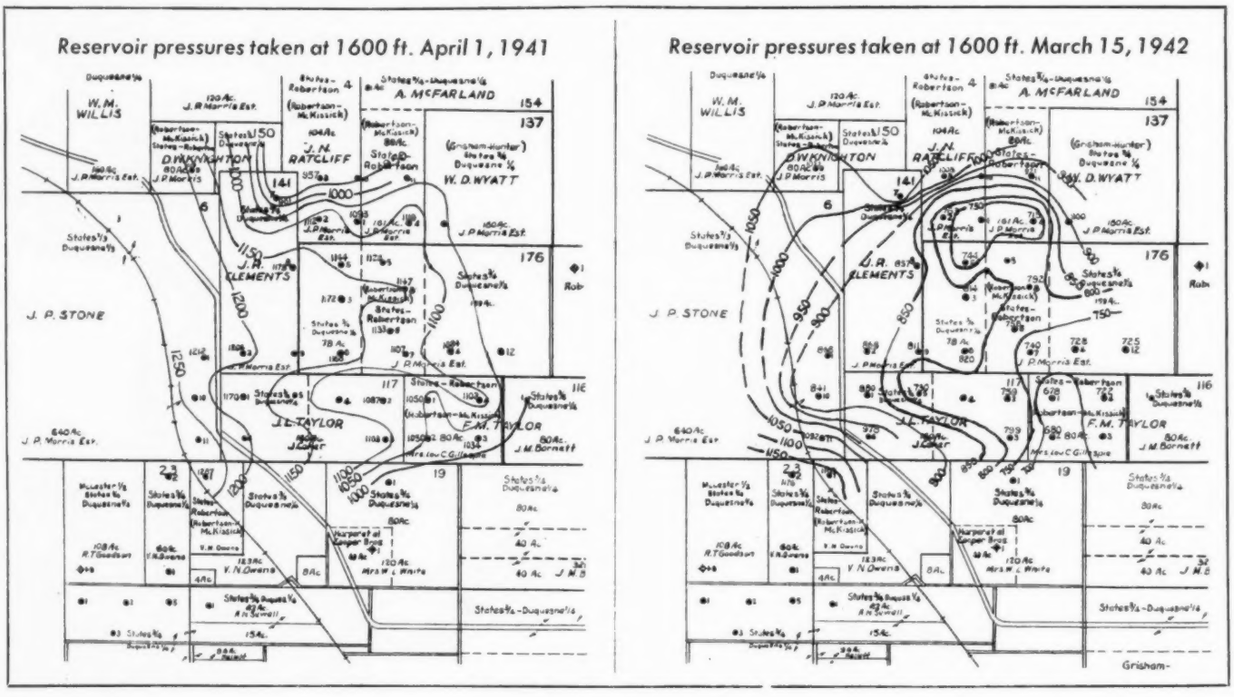
Close-up of scrubbers and intercoolers. Suction and discharge manifolds not visible. Raw water distribution and gas controls are shown. Very simple dump traps are partially visible on three of the scrubbers. Mercoid liquid-level controls are visible. Simple traps work very well and are much less expensive. Two Mercoids not yet installed. Blowdown and gasoline lines are shown passing under the walk. Dump traps must have water drain as the water freezes and blocks discharge lines. Each scrubber has blowdown connection not shown

tion well had a predetermined initial injection pressure and a predetermined injection pressure for the volume that it was intended it should receive. When operations were begun, these calculations were proved correct and still check after five months.

Plant Construction

With the volume of gas being produced, suction and discharge pressures, gasoline content, gas heat valves, etc., determined, contract was let for construction of the plant and field gathering and injection systems.

At is was expected that conditions would vary considerably, and in order to have as flexible a plant as possible to meet these variations, two 300-hp., 4-cycle, 3-stage compressors were specified. It was also specified that the plant should be so designed that either engine could operate separately or both could operate from common headers. The engines were to be cooled by a proper soft water system, and the compressors and intercoolers by rain water from the cooling tower basin. Each field tank battery was to have a proper meter-run and bypass vent, and the plant a master meter and a discharge meter for each injection well. Field scrubber, intercoolers, and interstage level shut downs, were included. Overload release on the suction header was provided, as was an overload bypass on the discharge header to the suction header. All manifolds were "stuffed out" and the plant laid out for extension, should the amount of gas to be handled increase beyond the capacity of the two-engine compressors. Gasoline lines, scrubber blowdowns, and pressure-relief blowdowns were all run into headers and carried beyond the plant site as a safety precaution and for ease in construction and operation. As shown in the accompanying photographs, the intercoolers, scrubbers, control valves, etc., were placed away from the engine house. This was done

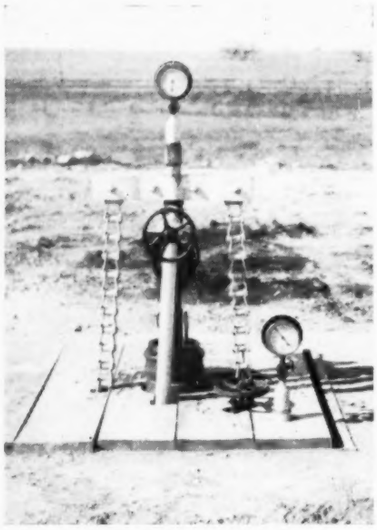


THE DOUGHBOYS OF '18 — SERVE AGAIN!

While the passage of a quarter-century has grayed his hair and lined his brow, it has in no way dimmed the memory of his Great Adventure. Wistfully he sees himself as he was in '18—young, eager, unafraid. Vividly he recalls the day when the fate of the world rested on the sturdy shoulders of him and his kind . . .

From bitter first-hand experience, this man knows that modern battles cannot be won by soldiers alone. An all-out war calls for the all-out effort of every man, woman and child with a stake in victory. It demands sweat and sacrifice, single-minded determination and wholehearted devotion to the task at hand. . . . And never through his fault will an American soldier suffer or die through lack of the support that these qualities provide. . . . Gaso Pump & Burner Mfg. Co., 902 E. First Street, Tulsa, Okla. Export Office: 149 Broadway, New York. Houston: 5716 Buffalo Speedway, Los Angeles: Service Oil Field Supply Co., 5333 S. Riverside Drive.

GASO PUMPS
for every oil industry need



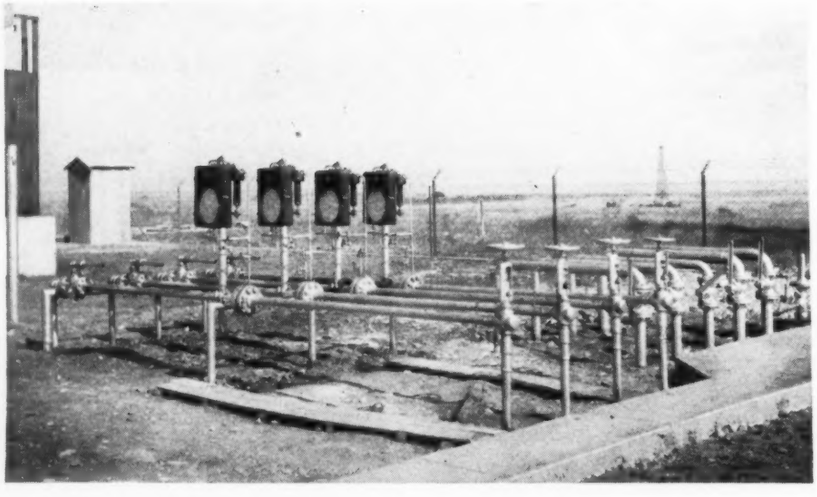
A typical producing well. Tubing gauge is 520 lb.; casing gauge 720 lb. The pressure on the tubing is a little higher than average; the casing pressure is about average

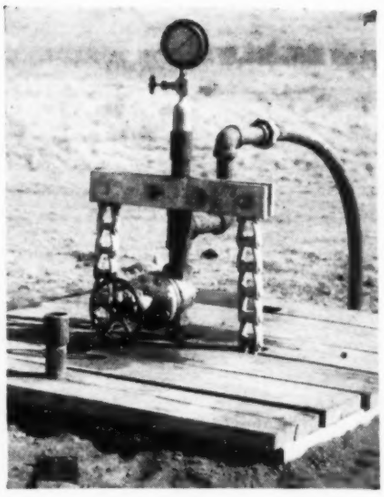
for three reasons. First, ease of handling, as suction, discharge, bypass, and blowdown controls would all be at one point. Second, by so placing the equipment, expansion loops could be eliminated; the installation of valves aboveground could be such that they would serve as expansion loops and be more convenient for operation, at the same time all gas controls would be at one location. Third, it would give proper access to the compressor side of the plant building for trucks, etc., when cylinder repairs would be necessary, thus eliminating the possibility of outside equipment having to be offset, which would require multiple pipe bends and expansion loops on the space left free. It was decided to leave the space free and use the same space for the added utility of removing the tube nests from the intercoolers, thereby reducing the size of the plant site.

Starting compressors, lighting inlets, oil storage, etc., were placed in a separate building in order to reduce fire hazard and insurance rates. Another consideration was making proper provision in the design of the main building for extension should additional units ever be required. The cooling tower was so designed and connected that additional soft water coils and bays could be added, although neither was considered likely unless three completely loaded 300-hp. units were installed.

All controls from the field into the suction header were designed to come together as a manifold, so that gas could be selected from any part of the field. Further, the design was for all injection gas to go out through a manifold and a meter-run to each injection well. In this manner, any line, tank battery, well, or equipment could be repaired without hampering operations. As all field batteries were equipped with automatic vents set slightly above plant pressures, if the plant vent became overloaded, the field vents would care for the excess gas. In the same manner the plant operator could shut off any suction line without notice to the lease operator knowing that no damage would be done. Specifications were for injection gas to pass through a common adjustable angle choke before entering the meter runs, the meter measuring the volume of gas and also giving the plant operator, within reasonable limits of error, the pressure at which the well received the gas. By placing gauges at the injection wells, the operator could then determine line losses and injection pressure without leaving the plant site.

Suction and discharge manifold. Excess pressure relief on suction is shown at extreme right. Expansion loop is outside fence to left of left choke. Plant site not yet filled and graded. Supports under meters and stop valves are necessary to prevent vibration





One of four injection wells. Injection line enters from right. By using pipe bend and half swing no expansion loop is required. No hammer is noticeable at the well. Expansion loops are used on each injection line outside the plant site. The gauge reads 1350 lb.

Gas Injection

No trouble developed during testing and injection was begun immediately. At first, very small volumes of gas were introduced into the well tubing of the injection wells, and the calculations of injection pressures checked extremely well. Rates of injection were slowly increased over a 90-day period approximately until full load was reached, at which time all calculations for pressures and capacities were checked and found to be closer than had been expected.

Only a few minor troubles have developed to date. Regulation of the conventional separator vent valves had to be made and they caused some trouble. The tendency of separators to overload and force oil into the gathering line and fill the field scrubbers, thus shutting down the plant, had to be corrected. Regulating field production to allowables and constant plant load has been the greatest problem.

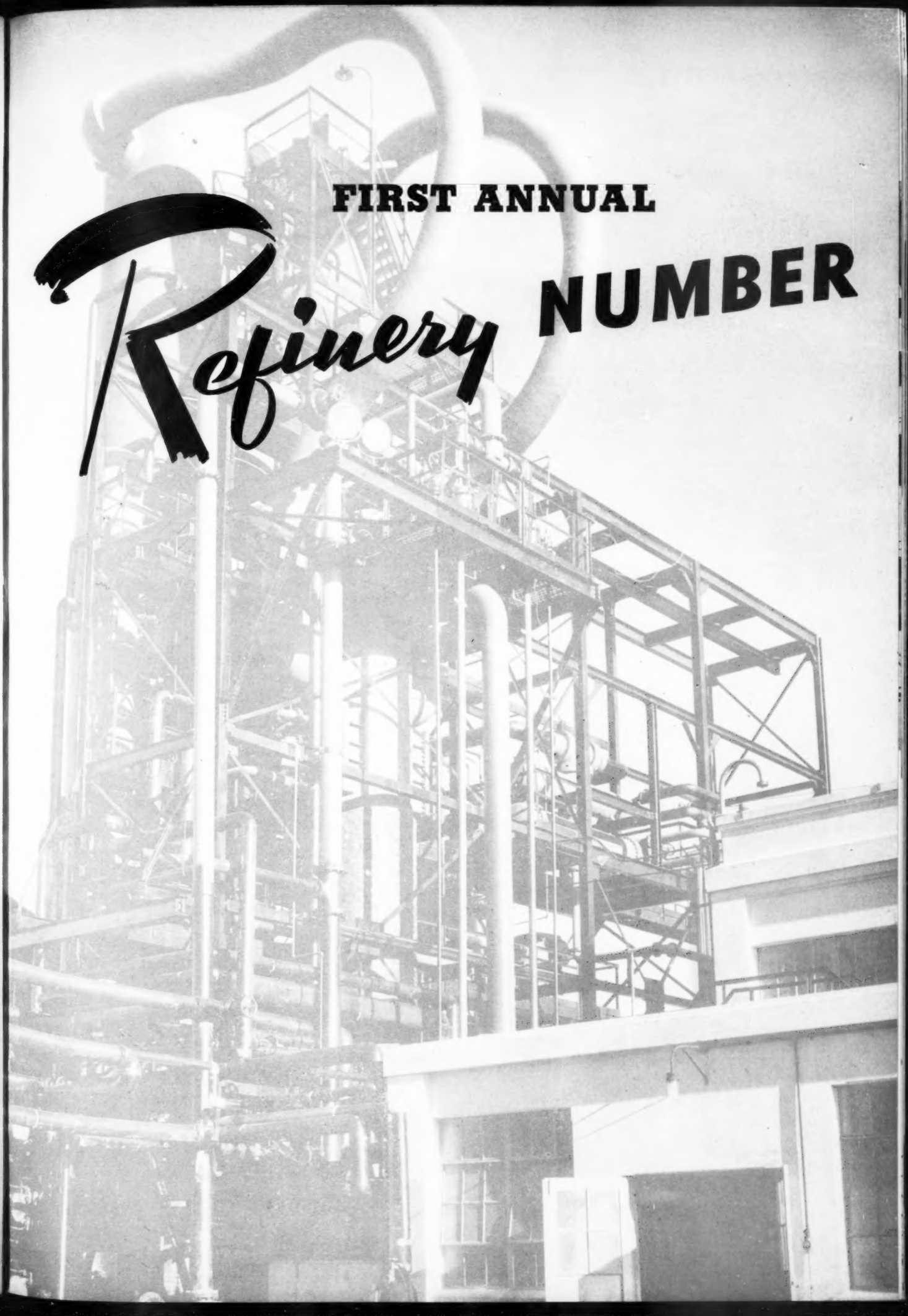
No trouble has occurred with the key wells.

Cooling tower trouble developed, but it is now being solved by better water distribution. Excess water over the tower prevented proper air circulation and some trays had to be stood on edge. The tower bottom tray was overloaded and a weir box had to be cut in to prevent overflow.

Injection lines had to be have drips installed, as solid plugs of ice were forming. This freezing has now been eliminated. Drips were installed on the suction system when laid.

W. H. Bowden, Tyler, Texas, was the contractor in charge of constructing the plant and field lines.

☆☆☆



FIRST ANNUAL

Refinery NUMBER

What Can Be Done About Sulphur

A. W. TRUSTY

graduated from Mississippi College in 1925 with a bachelor's degree—Joined staff of Lion Oil Refining Company as chemist and that same year (1925) transferred his affiliation to the Louisiana Oil Refining Company—In 1928 he became chief chemist of that company, which position he retained when later it became the Arkansas Fuel Oil Company—Resides in Shreveport, Louisiana.

☆ **Effective methods have been developed to combat sulphur, which is responsible for much of the corrosion to refinery equipment**

PETROLEUM ENGINEER Exclusive Feature

by A. W. Trusty, Chief Chemist, Arkansas Fuel Oil Company

THE average cost of corrosion to the refiner is one cent per gallon of refined gasoline. Sulphur in various forms is largely responsible for this high replacement cost of metal. Treatment of high sulphur distillates to lower the total sulphur content below the 0.1 percent maximum set up by the Federal Government, and most of the state inspection departments, has cost the refiner additional millions of dollars. The sulphur content of gasoline has a marked effect on the tetraethyl lead susceptibility and on the gum inhibitor susceptibility. Much of the research and literature has been devoted to a study of the chemical reactions of sulphur compounds. Sulphur has presented an extremely difficult problem, but the refiner has developed some effective methods of combating this insidious and versatile enemy.

Practically all the simpler types of organic sulphur compounds have been identified in petroleum oils. These compounds range from the very poisonous and corrosive gas, hydrogen sulphide, to the relatively innocuous and mild-mannered thiopene. Sulphur compounds identified by U. S. Bureau of Mines investigators are shown in Fig. 2[1].

Type	Odor	Corrosive to copper strip	Doctor test
Hydrogen sulphide	rotten eggs	yes	positive
Mercaptans	skunk	slightly	positive
Disulphides	none	no	negative
Sulphides	none	no	negative
Thiophenes	none	no	negative

[1]John S. Ball, R. I. 3591, December, 1941.

Hydrogen Sulphide

Two sulphur compounds of most interest to the refiner are hydrogen sulphide and the mercaptans. These two compounds are responsible for a great part of the refinery corrosion, and are more involved in treating problems than are the other types of sulphur compounds.

Hydrogen sulphide, a gas at ordinary temperatures and pressures, is frequently found in crude petroleum and distillates. The H_2S content of some sour gas fields is shown:

Source of gas	Grains of H_2S per 100 cu. ft. of gas	H_2S content percent by volume
Crane-Upton, Tex.	5,000	7.9*
Winkler, Texas	10,000	15.8
Kenton, Ohio	250	0.39
Glasgow, Kentucky	1,840	2.9
Schuler, Arkansas	30	0.04
McKamie, Arkansas	4,500	7.1
Patton, Arkansas	9,000	14.2

*1 percent by volume is equivalent to 635 grains per 100 cu. ft.

Hydrogen sulphide is generally more soluble in petroleum hydrocarbons than in water, and is more soluble in aromatic oil than in paraffin distillates.

Solvent	Volume of H_2S dissolved[2] per unit of solvent at 68° F.
Water	2.91
Hexane	6.3
Octane	6.8
Dodecane	5.7
Cyclohexane	7.5
Benzene	15.7
Toluene	16.9

Hydrogen sulphide may be liquefied at ordinary temperatures under a pressure of 250 lb. The liquid boils at minus 76°F. and solidifies at minus 119°F. The gas is slightly heavier than air (specific gravity 1.19), is inflammable, and burns with a blue flame.

In the presence of a small quantity of air, free sulphur is deposited:

$$2\ H_2S + O_2 = 2\ H_2O + 2S$$

[2]Ellis, Chem. of Pet. H. C., p. 423.

This reaction explains the yellow deposit of sulphur so frequently noticed in tanks, gas lines, and the vapor systems handling oils of high sulphur content.

Hydrogen sulphide is nearly as poisonous as hydrocyanic acid gas, and more so than carbon monoxide. Concentrations of H_2S stronger than 0.1 percent produce immediate paralysis of the breathing system. The sense of smell is paralyzed in dilutions greater than 0.01 percent. The gas is an irritant and combines with the alkali of the body fluids, tears, saliva, and blood serum, to form sodium sulphide, which is extremely caustic. A concentration of 0.1 percent by volume is fatal.

Hydrogen sulphide can be removed from petroleum products by an alkaline wash. Caustic soda solution is usually employed for scrubbing liquid petroleum fractions, but cannot be used economically in the case of gases containing considerable hydrogen sulphide. The spent caustic soda cannot be reclaimed, whereas other alkaline solutions, such as triethanolamine, used by the Girbotol Process, or potassium phosphate, used by the Shell Process, can be purified and used repeatedly.

Shell Phosphate Process

The Shell phosphate process consists of two steps: absorption, or scrubbing the gas with a solution of tripotassium phosphate, and regeneration of the spent solution. The reaction is reversible:

$$H_2S + K_3PO_4 = KHS + K_2HPO_4$$

A typical plant scale treatment of 3,500,000 cu. ft. of cracking plant gases reduces the H_2S content from 2250 grains per 100 cu. ft. to 100 grains. The gases are contacted in a 36-plate column, 48 in. in diameter, under a pressure of 175 lb. per sq. in. and a temperature of 175°F. About 40 gal. per min. of solution is regenerated in the stripping section, using a total of 91,550 lb. of steam. The H_2S from the top of the stripper column is burned in a waste products burner.

Increased efficiency of the extraction is accomplished by giving the gas a two-stage contact. A 50-Baumé solu-

in the Refinery?

tion of the tripotassium phosphate is first used to remove the bulk of the H_2S. A 19-Baumé solution is used in the second wash, as a weaker solution is more effective in removing the last portion of the H_2S.

Steel equipment is used throughout the system and corrosion has been negligible.

Girbotol Process

The principle of the Girbotol Process is based on the fact that aliphatic amines, such as triethanolamine, have a strong affinity for acid gases such as hydrogen sulphide and carbon dioxide at or near atmospheric temperature, but at higher temperatures the affinity declines rapidly and the gas is expelled.

The cycle and equipment are similar to that of a conventional absorption plant, with the amine solution being used as an absorbing medium instead of a petroleum oil. The saturated amine solution passes to heat exchangers, where it is heated to 200°F., and then into the reactivator. A reboiler strips the solution of all gases. The solution is then cooled and returned to the absorber.

The hydrogen sulphide gas leaves the reactivator saturated with water vapor at a temperature of about 200°F. The water is condensed and returned to the system. The gas is burned in a flare, or as in the case of one California refiner, the H_2S gas is used as the source of sulphur for a sulphuric acid plant.

A Girbotol unit in Arkansas is desulphurizing a natural gas that contains 4500 grains of H_2S per 100 cu. ft. The treated gas will pass the Bureau of Mines lead acetate test for the presence of hydrogen sulphide.

The Girbotol Process can be used to desulphurize feed stock to polymerization units at a temperature as high as 180°F.

Mercaptans

The mercaptans of lower molecular weight have very disagreeable odors. Ethyl mercaptan, because of its penetrating odor, is used as an odorant for the detection of leaks in gas mains. The heavier molecular weight mercaptans, however, such as myricyl mercaptan ($C_{30}H_{61}SH$), are odorless. Some aromatic mercaptans of fairly low molecular weight, such as O-xylene di-mercaptan, have been described as odorless.

The mercaptans have higher boiling points than the corresponding hydrocarbon.

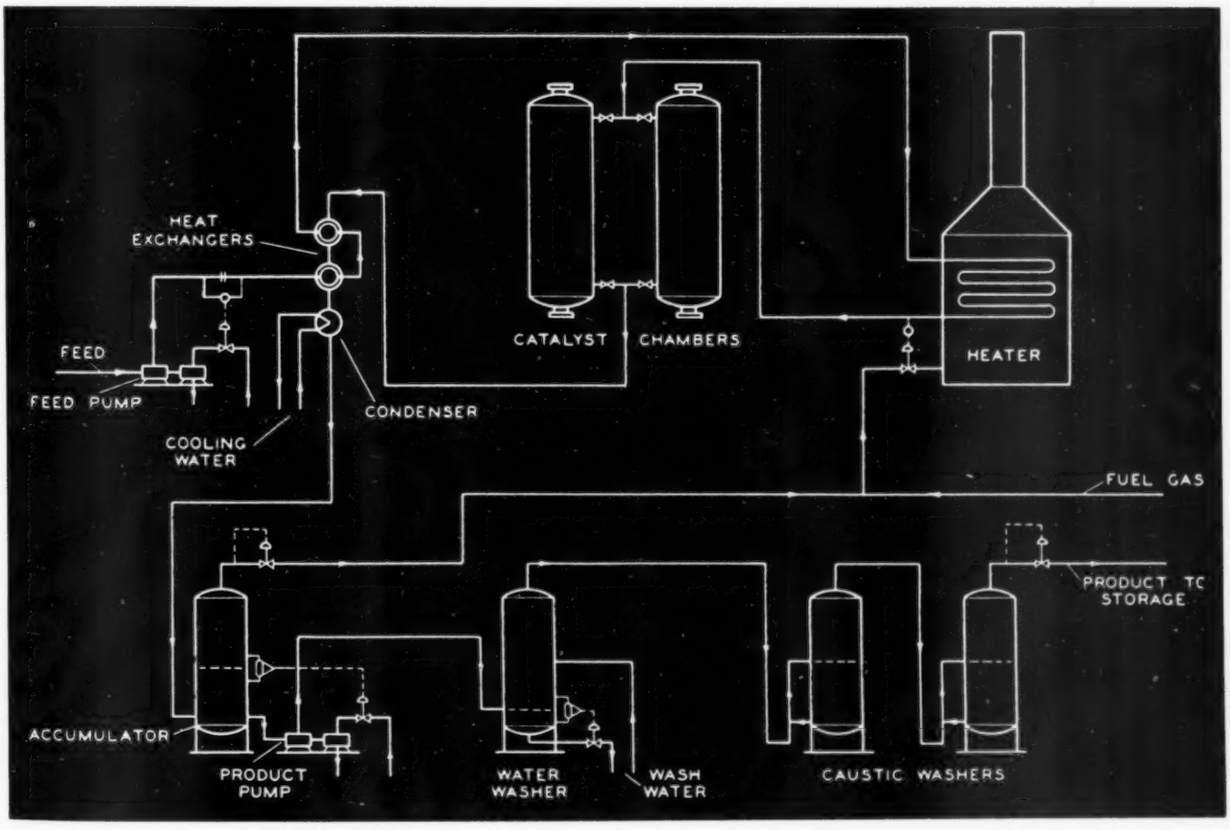
Hydrocarbon	Boiling point
Methane	—258° F.
Ethane	—127
Propane	— 44
Butane	32
Pentane	97

Mercaptan	Boiling point
Methyl mercaptan	—189° F.
Ethyl mercaptan	95
Propyl mercaptan	154
Butyl mercaptan	208
Pentyl mercaptan	259

Doctor Sweetening

Treatment of a sour distillate with doctor solution and sulphur is one of the oldest of chemical treating methods. It was first adopted in Ohio to overcome the odor of the distillates from new crude oil production in that area. Doctor treatment has served its purpose for many years, and it was only when tetraethyl lead blending became so universal that the harmful effects of this treating method began to

Fig. 1. Catalytic desulphurization process



be recognized. The adoption of chemical gum inhibitors as a substitution for other methods of chemical treatment, such as vapor-phase clay treatment, and sulphuric acid treatment with rerunning, also brought to the attention of the refiner the necessity for careful control of the doctor sweetening operation. Several treating methods such as the Perco copper treating process and the Hoover system have been developed in the attempt to overcome some of the disadvantages of the doctor treatment.

Lowry[3] has shown the effects of improper doctor treatment on gum inhibitor response in treating a West Texas cracked gasoline:

Added sulphur, percent	0.00	0.0075	0.015
Induction period, min:			
No inhibitor	200	115	100
0.013% V. O. P. No. 4	380	285	175
Copper dish gum:			
No inhibitor	299	327	357
0.013% V. O. P. No. 4	5	74	138

[3]Lowry, *Ind. Eng. Chem.*, November, 1938, p. 1275.

In these treatments, sulphur was added to the gasoline before contact with doctor solution. The doctor sweet gasoline was non-corrosive to the copper strip in each case. Sulphur added after the gasoline has been sweetened does not usually affect the gum inhibitor susceptibility. Apparently the excess free sulphur shown in the table was not actually elementary sulphur, but was mostly polysulphides, formed during the sweetening operation.

These results show the importance of careful control of the sweetening operation:

a. Best results can be obtained by holding the temperature of the gasoline above 85°F.

b. The sulphur should be added in solution in sweet rather than sour gasoline.

c. The sulphur addition should be made following the doctor contact rather than preceding it.

d. It is important to have sufficient contact time of the doctor and sour gasoline. Insufficient contact time requires more sulphur to produce the break.

Doctor treatment almost invariably lowers the octane number slightly and decreases the tetraethyl lead susceptibility. A thorough caustic wash partially to remove the mercaptans before the doctor treatment will reduce the harmful effects of doctor treatment. The following table shows the extent to which the lead susceptibility is affected:

	Cc. of tetraethyl lead per gal. to obtain:		
	70 Octane	77 Octane	Mercaptan sulphur, per cent
Cracked gasoline from Texas crudes, sour	0.48	1.72	0.011
6-stage caustic wash	0.46	1.70	0.002
Doctor sweetened only	0.50	1.98	0.000
Cracked gasoline from Michigan crude, sour	1.32	....	0.060
6-stage caustic wash	1.11	....	0.011
Doctor sweetened	1.85	....	0.000

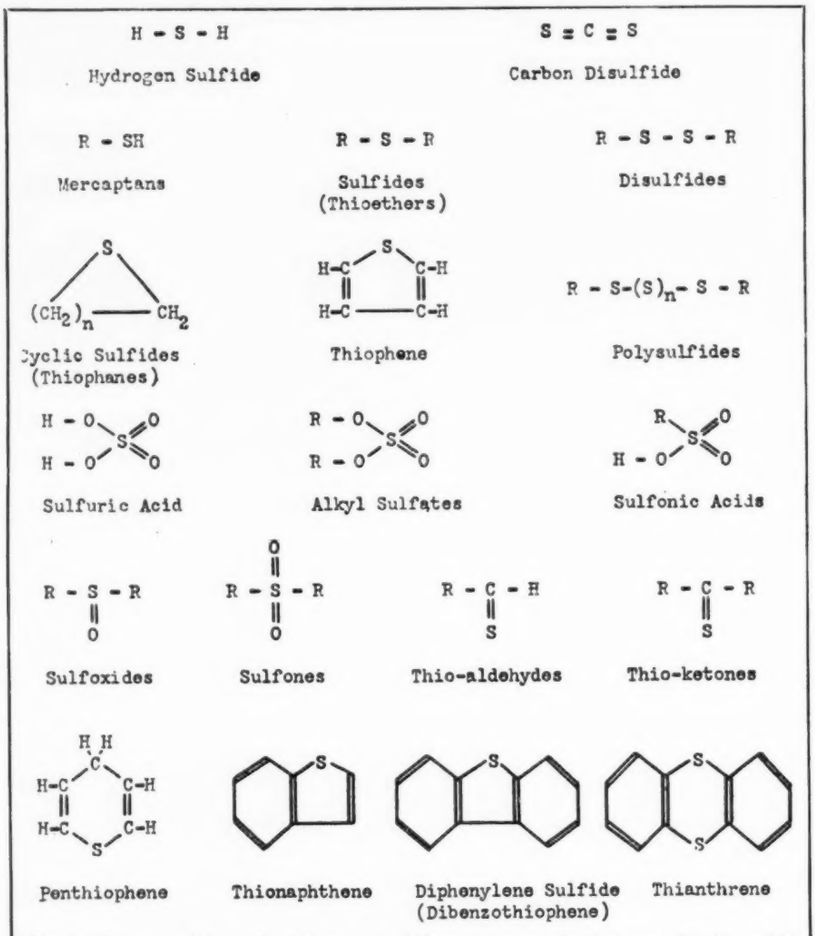


Fig. 2. Structural formulas of some sulphur compounds that may be found in petroleum distillates. R may stand for any aliphatic or aromatic group. n may be one or any whole number greater than one

It is noted that thorough caustic washing will remove 80 percent or more of the mercaptans from a typical cracked gasoline. In several commercial installations, where refiners give their gasoline a caustic wash previous to doctor treatment, as much as 88 percent of the total mercaptan content of the sour stock was reported removed.

The light mercaptans are easily extracted by an alkaline wash. The higher molecular weight mercaptans are not very soluble in the alkali. For example, the following table shows the comparative ease with which the mercaptans are removed by half the volume of a 5 percent sodium hydroxide solution:

Mercaptan	Per cent extracted
Methyl	100.00
Ethyl	97.1
N-propyl	88.8
i-propyl	87.2
n-butyl	63.2
i-butyl	62.8
i-amyl	33.0

The trend is now toward elimination of the "doctor test" specification from the requirements set up by most sales departments. It has been suggested that a mercaptan content specification be substituted for the doctor test, including a provision for the removal of the light mercaptans. A specification reading: "The maximum content of mercaptans shall be 0.005 percent (or 0.008 percent) by weight, none of which can be removed with a 5 percent caustic soda solution wash" has a lot of argument over the antiquated doctor test. For example:

1. The present doctor test will de-

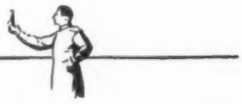
DESIGNS FOR VICTORY

The designs for Alkylation and Toluene units, Natural Gasoline and Gas Recycling plants—as well as plants of related kind—now being engineered on Fluor drafting boards are, in actuality, *Designs for Victory!*

Since its outbreak, it has been apparent that this is a War of fighting men *and* fighting machines. Ultimate Victory will go to him who has the most highly trained fighting men, backed by the best and greatest number of fighting machines, lubricated and fueled with the finest petroleum products, flowing in endless stream from the most and best refineries. The application of the most modern technological advances to the engineering and design of refinery units and related plants *plus* speed balanced by vigilant craftsmanship in their construction is Fluor's function in the Winning of the War.

To meet the unprecedented demands of the War, Fluor has expanded and expanded its physical facilities until the expansion has become fourfold. With an united will, Fluor personnel in all departments is meeting the demand for increased output with longer hours and an expanded working week. *There's a job to be done!*

But, vital as today's needs are—and in spite of capacity operation—Fluor recognizes that tomorrow's needs are likewise vital. Technology is not—cannot be—static. Advances must be made. If tomorrow is a tomorrow of War, they must be applied to its Winning. If tomorrow is a tomorrow of Peace, they must be applied to the task of world rebuilding. Thus,



tomorrow's Designs for Victory are being planned *today* in Fluor's Research and Development Laboratory. Engaged today at capacity in an all-out effort to assure Victory, *Fluor will be ready for tomorrow!*

DESIGNERS — ENGINEERS — CONSTRUCTORS

FLUOR

THE FLUOR CORPORATION LTD. *Main Office and Plant:* 2500 South Atlantic Blvd., Los Angeles, California

NEW YORK CITY • PITTSBURGH, PENNSYLVANIA • KANSAS CITY, MISSOURI • HOUSTON, TEXAS

SINCE 1890

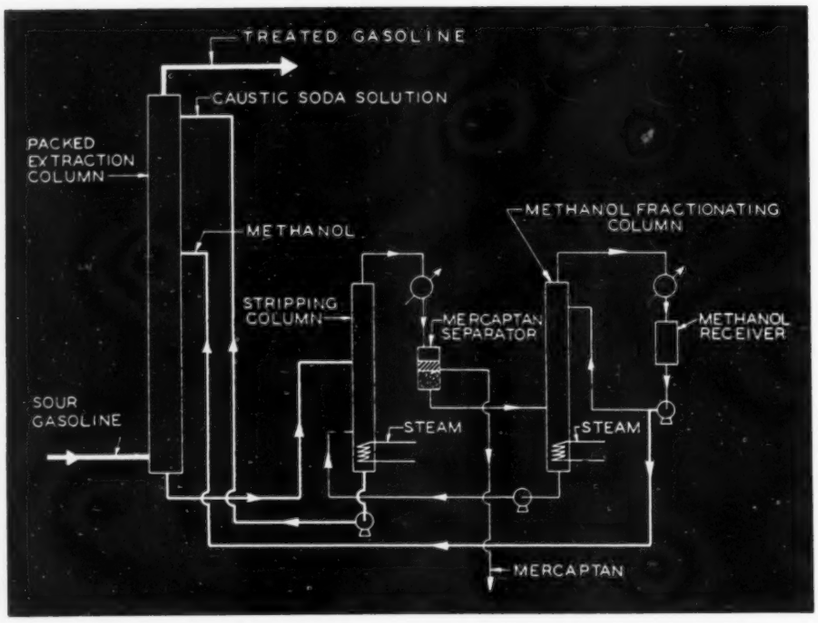


Fig. 3. Methanol treating system

tect the presence of 0.002 percent of mercaptan and 0.0002 percent of butyl mercaptan. There can be little argument about the relative qualities of two gasolines with or without such a small amount of impurity.

2. The light mercaptans have the bad odors. If the light mercaptans are removed, there is usually little improvement in odor by the removal of the small amount of heavy molecular weight mercaptans.

3. Elimination of doctor treatment will result in a savings in tetraethyl lead and in gum inhibitor. For the duration of the war, it is not only patriotic but necessary that we reduce as much as possible the consumption of the tetraethyl lead and litharge.

Caustic Methanol Process

A new refining process has recently been put into commercial operation that improves the tetraethyl lead susceptibility of gasolines by removing the mercaptans. The flow is similar to the conventional absorption plant except that an aqueous solution of caustic soda and methanol is used instead of absorption oil. The spent alkaline solution is continuously regenerated by heating with steam, redistilling, and recovering the alcohol.

The mercaptans are completely removed from some gasolines; in others, the treated product is still slightly sour to the conventional doctor test but the mercaptan content is low, being 0.005 percent or less.

The circulation rate of caustic and methanol is low, usually about 3 percent by volume of the gasoline being treated. The loss of alcohol by solution in the gasoline also is low, usually about 0.004 percent by volume. Some typical results of treatments are shown:

	Mercaptan sulphur		Total sulphur		Octane number M. M.			
	Before	After	Before	After	Before Clear	Before +3.0 cc.TEL	After Clear	After +3.0 cc.TEL
West Texas straight-run gasoline	0.061	0.0003	0.125	0.055	69.8	79.0	71.5	83.0
Low sulphur cracked gasoline	0.023	0.0003	0.09	0.07	71.7	80.5	72.0	81.3
High sulphur cracked gasoline	0.050	0.0004	0.25	0.18	68.6	76.0	68.8	77.0

Solutizer Process

The Solutizer Process was developed to take advantage of the fact that when certain organic acids such as *iso*-butyric acid are added to the alkali and the resulting potassium *iso*butyrate is contacted with the mercaptans, the mercaptans are completely soluble and are removed by the alkaline wash. Thus the gasoline is completely sweetened to the doctor test.

The advantages offered by the Solutizer Process are a reduction in total sulphur content by removal of the mercaptans, and an increased tetraethyl lead susceptibilty due to the sulphur removal.

The cycle and equipment is similar to the conventional absorption plant. The alkaline *iso*butyrate is contacted with the sour gasoline in a carbon ring packed tower. The rich alkali solution is then passed through heat exchangers and into a stripper column. A reboiler heats the solution to a temperature of about 290°F. before the alkali is cooled to be again circulated through the gasoline-contactor tower.

The gaseous mercaptans from the top of the stripper are either burned for disposal or used for chemical syntheses.

Catalytic Desulphurization

Considerable work has been done by several investigators to study the effect of sulphur compounds on the lead susceptibility of gasoline. The polysulphides formed during doctor sweetening appear to be the worst offenders. Disulphides and mercaptans also contribute to the ineffectiveness of the tetraethyl lead. Thus complete desulphurization, or as complete as possible, should improve the leading quality of a gasoline.

A Perco catalytic desulphurization unit, installed in a natural gasoline plant near Clendenin, West Virginia, in 1940, reduces the total sulphur content from 0.26 percent to 0.004 percent. The gasoline is heated in a pipe still to a temperature of 750°F. and passed in the vapor state through a bauxite catalyst under a pressure of 40 lb. The organic sulphur compounds are catalytically converted into hydrogen sulphide. The treated gasoline is condensed, cooled, and scrubbed with caustic soda to remove the hydrogen sulphide. Catalyst yield is 4000 to 5000 bbl. of gasoline per ton. When the catalyst becomes spent, as evidenced by the condensed gasoline becoming sour to the doctor test, the bauxite is discarded and replaced with a fresh charge.

Results of treating a stabilized natural gasoline:

	Before desulphurization	After desulphurization
Octane number	51.4	54.8
Octane number with 1.0 cc. TEL per gal	57.5	67.8
Octane number with 2.0 cc. TEL per gal	61.2	74.2
Total sulphur, percent	0.26	0.004
Doctor	positive	negative
Corrosion	negative	negative
Color	30	25
I. B. P.	146°	130°
10 percent at	169°	164°
90 percent at	244°	244°
E. P.	340°	342°

Types of Sulphur Compounds

Ball[1] of the U. S. Bureau of Mines has investigated several methods of determining types of sulphur in petroleum distillates. He has tested the best of the published methods and the following system of analysis has been suggested as a short and accurate procedure.

1. Determine total sulphur in the oil by lamp method.

2. Hydrogen sulphide and mercaptans by silver nitrate titration.

Ten ml. of the untreated oil is pipetted into an Erlenmeyer flask. An excess of 0.05N.$AgNO_3$ is added. Ferric alum indicator is added and the mixture shaken thoroughly. Ammonium thiocyanate (0.05N.) is added from a burette with vigorous shaking until the water layer retains a pink color.

This titration is repeated on 10 ml. of the oil that has been washed with acidified cadmium chloride solution to remove H_2S. A yellow precipitate indicates the presence of hydrogen sulphide.

$$\frac{T_1 - T_2}{2} = \text{sulphur as } H_2S.$$

T_2 = sulphur as mercaptans, or

$$\frac{\text{ml. } T_2 \times 0.05\,(\text{normality}) \times 3.206}{10\text{ ml.}\,(\text{oil}) \times \text{sp. gr.}} =$$

percent mercaptans.

Determination of free sulphur. To 50 ml. of the oil, from which the hydrogen sulphide has been removed by cadmium chloride treatment, is added 1 ml. of butyl mercaptan solution. (If more than 0.02 percent free sulphur is present a corresponding increase is made in the amount of butyl mercaptan added.) A silver nitrate titration is made on a 10-ml. portion of the mixture (operation T_3). The remainder is shaken with 10 ml. of plumbite solution. The plumbite solution is allowed to settle and the clear portion is drawn off, taking care not to remove any precipitate. The oil is then shaken with 25 ml. of 20 percent sulphuric acid until the original color of the oil is restored. The acid layer is drawn off and the oil is washed with 25 ml. of acid cadmium chloride solution. A silver nitrate titration is then made on the oil (operation T_4).

As an atom of sulphur is equivalent to two molecules of mercaptan, the difference between the two titrations (T_3 and T_4), divided by two, equals (after the blank is subtracted) the free sulphur in the sample.

Determination of disulphides. Fifty ml. of the oil that has been treated with mercury and silver nitrate solution is placed in an Erlenmeyer flask with 10 grams of granulated zinc and 50 ml. of glacial acetic acid and refluxed for 3 hours. This procedure reduces the disulphides in the oil to mercaptans. The oil-acid mixture, after the zinc is cooled and separated, is diluted to 250 ml. with distilled water. The water is separated and a silver nitrate titration made on a portion of the oil (operation T_7). The disulphide sulphur content of the sample is equal to the mercaptain sulphur value found by this titration.

Determination of aliphatic sulphides. The remainder of the oil that has been treated with mercury and silver nitrate is shaken thoroughly with one-third its weight of pulverized mercurous nitrate and filtered. This treatment is repeated twice, and the oil is then washed three times with an equal volume of distilled water. The oil is then filtered and the lamp sulphur determined (operation L_4). The difference between the value for lamp sulphur after treatment with silver nitrate (L_3) and this value gives the sulphur present as aliphatic sulphides. To this difference is added any sulphide sulphur removed by silver nitrate and found under the check on hydrogen sulphide and mercaptans. The additional products are either precipitated or removed by water washing.

Determination of aromatic sulphides and thiophenes. The remainder of the oil from the mercurous nitrate treatment is shaken thoroughly with one-third its weight of pulverized mercuric nitrate and filtered. This treatment is repeated twice, and the oil is then washed three times with its own volume of distilled water. The oil is then filtered and the lamp sulphur determined (operation L_5). The difference between the lamp-sulphur value after mercurous nitrate treatment (L_4) and this value gives the sulphur present as aromatic sulphides, thiophenes, and disulphides. The aromatic sulphide and thiophene sulphur is determined by subtracting the previously found value for disulphide sulphur.

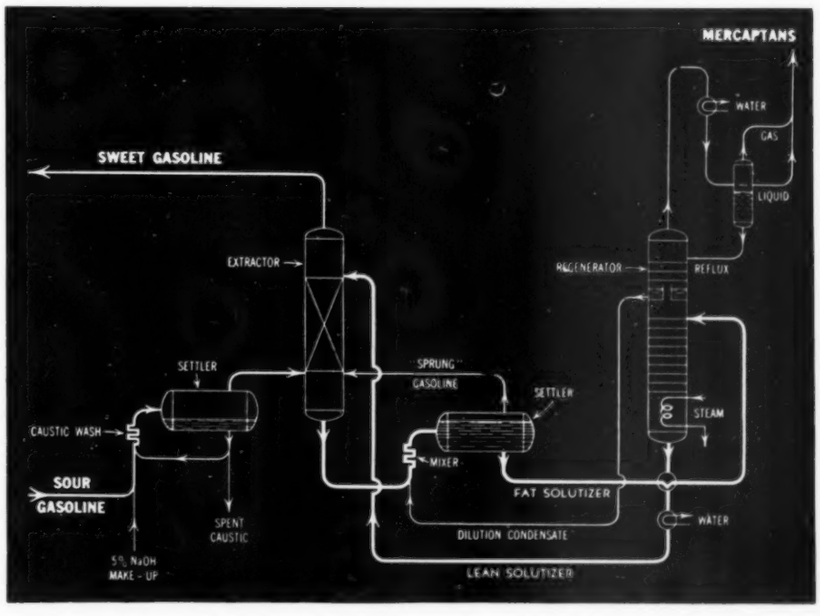
Residual sulphur. Although tests have been made for the common sulphur compounds expected in petroleum distillates, there is usually some residual sulphur, as shown by the lamp determination after the mercuric nitrate treatment.

Types of sulphur found in Oregon Basin, Wyoming, gasoline are:

	Straight-run gasoline	Cracked gasoline	Kerosine
Hydrogen sulphide	0.000	0.000	0.000
Mercaptans	0.002	0.049	0.000
Disulphides	0.023	0.028	0.003
Free sulphur	0.012	0.000	0.000
Aliphatic sulphides	0.158	0.04	0.313
Aromatic sulphides and thiophenes	0.002	0.38	0.289
Residual sulphur	0.018	0.77	0.213
Water soluble sulphur compounds	0.000	0.00	0.000
Totals	0.215	1.267	0.818

☆ ☆ ☆

Fig. 4. Simplified flow diagram of Solutizer Process



a four-point service plan to keep

1 **Renewal Parts Warehouses**
17 warehouses conveniently located throughout the country now carry an adequate stock of frequently used renewal parts.

2 **District Repair Service**
34 manufacturing and repair plants are strategically located to speed repair service.

3 **District Engineering Service**
Experienced engineers in every Westinghouse district office are available to help solve power problems.

4 **Free Help for Maintenance Men**
Valuable information on how to keep equipment on the job.

The success or failure of your efforts, as part of America's war program, depends on your power system. Failure anywhere may result in serious delay. To help you get more from your equipment—to keep it on the job longer—Westinghouse is prepared to help you in these four ways:

First Westinghouse has established 17 warehouses where you can obtain renewal parts quickly. Stocks on hand include those parts normally subjected to wear or burning, such as contact tips, shunts, arc chutes, operating coils, armature and field coils, bearings, etc. Be sure your own stock of renewal parts is adequate to meet emergencies. Before it runs low order direct from our local office.

Second Westinghouse has arranged to facilitate major repair work. In addition to the 17 parts warehouses, Westinghouse has established 34 district manufacturing and repair plants. Each of these plants is equipped to repair, remodel or recondition electrical, steam and geared drive equipment. This includes rewinding motors, generators, and transformers; major repairs of steam equipment; replacing or building up worn parts such as bearings, commutators and current collectors; complete repairs of turbines or remodeling them for other operations.

More than 4,000 employes are now serving our customers from these 34 Westinghouse district plants alone. To save time on repair service, call our nearest office.

Third Experienced engineers are available at every Westinghouse office to help you with your power problems. These men are constantly working with engineers in all types of industries. Problems that occur once in the lifetime of a particular operator are often daily occurrences with our engineers. Thus, the solution to these problems provides a quick answer to similar problems elsewhere.

Fourth The work being done by maintenance men is one of the most important jobs in the petroleum industry. "Keeping them running" depends on these men. They need all the assistance you can give them.

Westinghouse has prepared a valuable book on the care and maintenance of electrical equipment. Pocket-size, it gives helpful hints on bearing lubrication and maintenance, tips on general inspection and many other suggestions on how to keep electrical equipment on the job.

"Maintenance Hints" is free. Each of your maintenance men should have a copy. To be sure each gets one, fill in the coupon now and mail it today.

All of the above services are available through our local office. A phone call will bring you any one or all of them.

Westinghouse Electric & Manufacturing Company
East Pittsburgh, Pa.

Westinghouse

Petroleum Equipment running

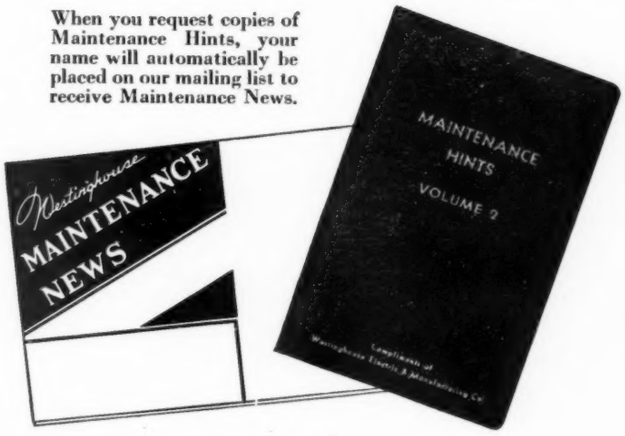
FREE

HINTS ON HOW TO MAINTAIN ELECTRICAL EQUIPMENT

Continuous output depends on proper maintenance. This book will help. Thousands of maintenance men are already using it. Gives timely tips on the care and maintenance of electrical equipment. Published in two volumes. You can have both. Vol. I is wire-bound. Vol. II is loose-leaf so additional booklets can be added as released.

Fill in this coupon now and mail it today. When we receive your request your name will automatically be placed on our mailing list to receive Westinghouse Maintenance News—another free publication for maintenance men, issued periodically to give latest news on maintenance methods.

When you request copies of Maintenance Hints, your name will automatically be placed on our mailing list to receive Maintenance News.



TIME-SAVER FOR THE PETROLEUM INDUSTRY

Westinghouse Elec. & Mfg. Co.,
East Pittsburgh, Pa., Dept. 7-N
Maintenance Sales Dept.:
Please forward copies of Maintenance Hints, to:

_____

_____

Company _____

Address _____

City _____ State _____

By _____ Title _____

J-94490-A

Petroleum Plastics— The Acrylic Resins

☆ **Versatile applications for new methyl methacrylate plastic include thousands of products essential to the national production program and for civilian use**

PETROLEUM ENGINEER Exclusive Feature

by C. C. Pryor
Assistant Editor

ONE of the more recent and perhaps one of the most significant of chemistry's contributions to the depression-born plastics industry is the development of methyl methacrylate resin. Basically derivable from petroleum, as shown in the diagrammatic sketch, the resin is one of the most important plastics yet discovered. Although methacrylic acid and some of its derivatives have been known for many years, it was only recently that recognition of the unusual properties of the methacrylic ester polymers stimulated the research that has led to their commercial development.

Acrylic resins were first made available in commercial quantities in the United States in 1931. Experiments had been made with acrylic acid derivatives prior to 1900, but the industrial development of these resins was not furthered until after publication in 1901 of the research of Dr. Otto Röhm, of Darmstadt, Germany.

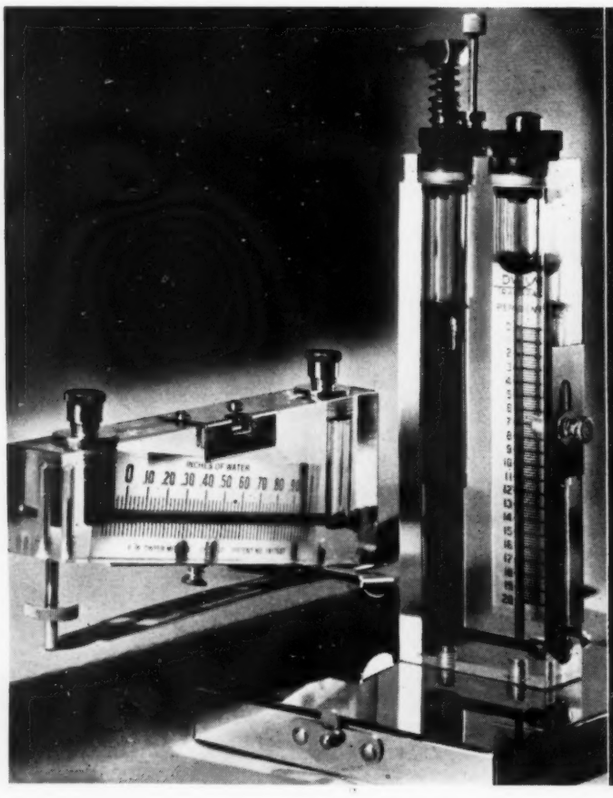
The acrylic and methacrylic resins are the resinous products resulting from the polymerization of the monomeric derivatives of acrylic acid. Included in this group are acrylic and methacrylic acids, their esters, amides, salts, halides, and nitriles. The esters are of the most importance from the commercial standpoint at the present time. These esters can be polymerized to form thermoplastic resins possessing unusual characteristics that have created an unprecedented demand by the extremely numerous industries manufacturing thousands of items from plastics. The methyl methacrylate resin may be transformed into granular molding powders suitable for use in standard processes of thermoplastic molding.

Structural Chemistry

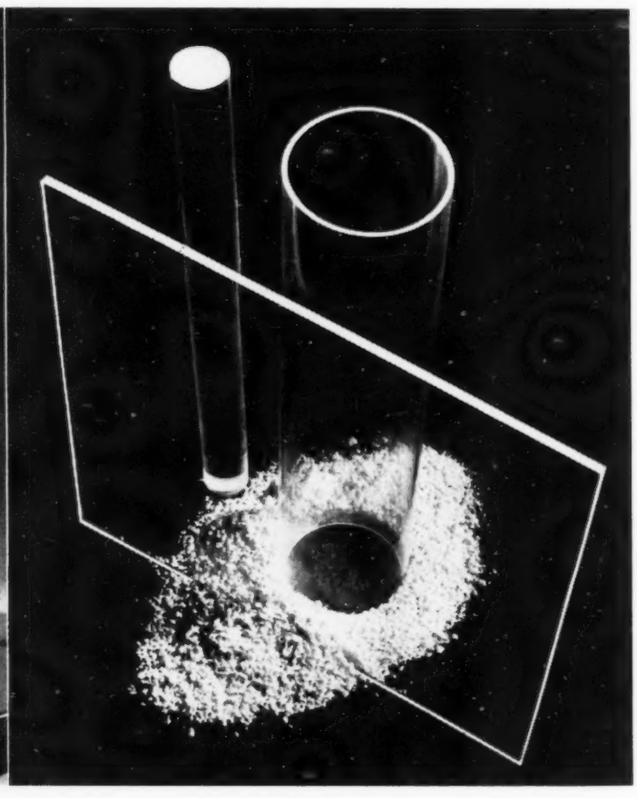
Acrylic acid has the structural formula $CH_2 = CH - COOH$. The structural formula of its derivative alpha-methyl acrylic or methacrylic acid is $CH_2 = C(CH_3) - COOH$. Beginning with ethylene chlorohydrin (See sketch) reactions involved in the synthesis of the acrylic acid esters are as follows:

1. $CH_2OH.CH_2CL + NaCN \longrightarrow CH_2OH.CH_2CN + NaCl$

Crystal-clear draft gauges and gas analyzers made from methyl methacrylate resin



A finished product of methyl methacrylate resin sheet, rod, tube, and molding powder



applied to . . . . .

• Plants producing Aviation Gasoline and Lubricants.

• Plants Producing Synthetics.

This is no time for indecision, delays and mistakes, installations must be completed on time or ahead of schedule and only as the Refining Industry does its job can we be assured that when the time comes we can "Get there firstis with the mostis."

Because of the many years experience in building combustion equipment for the petroleum industry, we are able to recommend the proper equipment for these new installations. Our manufacturing facilities enable us to furnish gas and oil burning equipment on schedule.

— 100 Per Cent on Defense Work —

FOR REFINERY, NATURAL GASOLINE AND SYNTHETIC PLANTS . . .

Webster Series R,
combination gas and oil Burner

Webster Radiant,
low pressure gas Burner

Webster Series VI,
premixing gas Burner

Webster Series 200 Radiant
gas or combination Burner

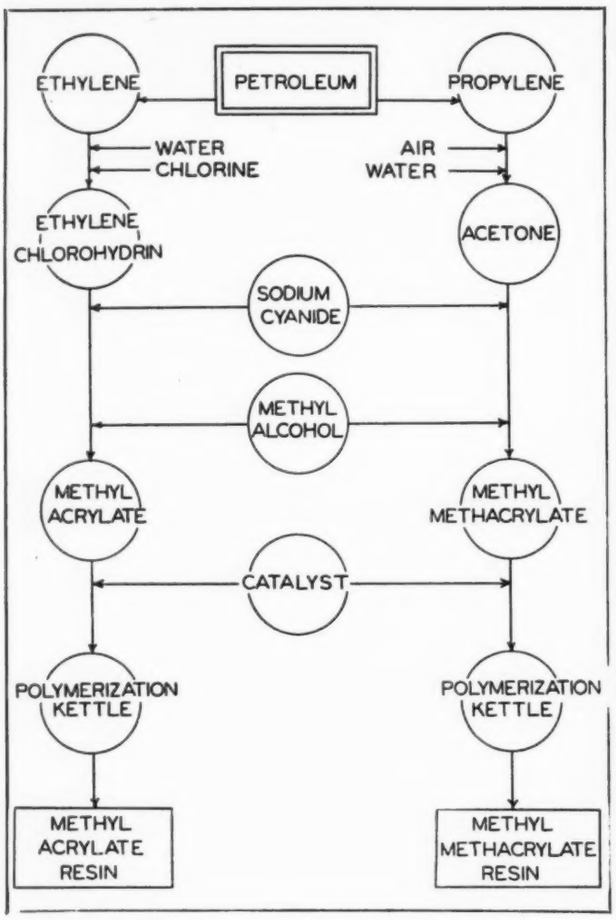
Webster Series 900
premixing gas Burner

THE WEBSTER ENGINEERING COMPANY

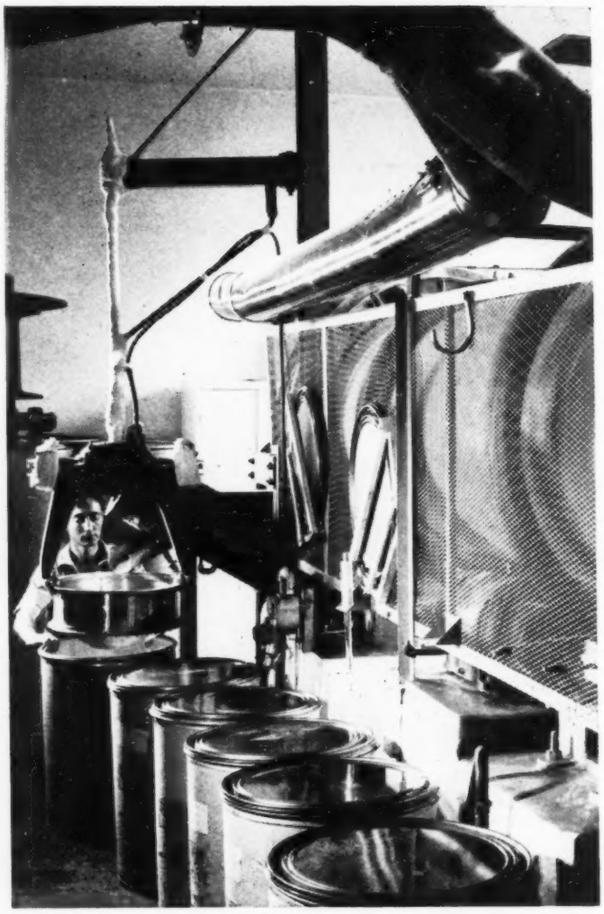
TULSA, OKLAHOMA

Division of SURFACE COMBUSTION

TOLEDO, OHIO



Diagrammatic sketch showing steps in making methyl acrylate and methyl methacrylate resins from petroleum



Photograph showing closed dryer from which the resin in molding powder form is being packed in air-tight drums

2. $CH_2OH.CH_2CN + ROH + H_2SO_4 \Longrightarrow$
$CH_2 = CH - COOR + NH_4HSO_4$

The methacrylic acid esters can be prepared by dehydrohalogenating alpha or beta halogenated isobutyric esters:

$(CH_3)_2CClCOOR \Longrightarrow$
$CH_2 = CCH_3COOR - HCl$

From acetone cyanhydrin as follows:

$(CH_3)_2COHCN - H_2SO_4 - ROH \rightarrow$
$CH_2 = CCH_3COOR - NH_4HSO_4$

Polymerization

Polymerization of both acrylic and methacrylic acid esters is accomplished under the influence of catalysts. This polymerization may be explained by assuming a chain reaction with the production of a linear-type polymer. Thus, the conception of the structure of the resins is that they are chains of various lengths formed by the linking of the original monomeric molecules. Polymerization of the ester is autocatalytic. Heat, light, oxygen, and oxygen-yielding substances such as sodium peroxide, hydrogen peroxide, and benzoyl peroxide, are the most commonly used catalysts. Mechanism of the polymerization is believed similar to that of other compounds containing vinyl groups. The growth of the polymer chain is considered almost instantaneous because of the extremely short time that the molecules remain active.

Characteristics

Methacrylate esters can be cast-polymerized directly into solid, glass-like resins in any desired shape in predesigned molds or it can first be polymerized in finely divided form that can be used as a molding powder and molded in any manner suitable for a thermoplastic resin. Pure monomeric esters are stable and can be stored cool for months without polymerization. The resins are all water-white, are stable to light and aging, and will not yellow under direct sunlight.

This polymeric resin has a clarity that rivals that of quartz crystal with an amazing light-carrying ability. Its color possibilities are as broad as the spectrum as it is readily pigmented. The material is tough, light in weight, and resistant to sunlight and outdoor exposure.

Acrylic resins vary from soft, sticky, semi-liquids to hard, tough thermo-plastic solids. The thermoplastic type resin is that made use of in the majority of plastic industries. The polymethyl methacrylate is of the hard type and made commercially both with and without plasticizer in meeting the numerous requirements of fabrication and other applications.

These resins have a limited compatibility with other synthetic polymers and natural resins. Some acrylic polymers are incompatible with each other and copolymerization of the monomers is necessary to obtain the desired variations. Of the five methacrylate resins, methyl methacrylate, ethyl methacrylate, normal propyl methacrylate, normal butyl methacrylate, and isobutyl methacrylate, the isobutyl and normal methacrylate polymers are the only polymers that are compatible with one another in all proportions.

Applications and Uses

Polymethyl methacrylate is an outstanding plastic material of either the cast or molded type due to its transparency, strength, high softening temperature, low specific gravity, and chemical resistance. Its value is in-

Properties of methacrylate resins

Property	Methyl	Ethyl	n-Propyl	n-Butyl	Isobutyl
Density—25°C	1.19	1.11	1.06	1.05	1.02
Hardness (Pfund)* G. at 25°C	220	141	100	1	310
Thermal Yield† Point °C	125	65	38	30	70
Tensile Strength—lb./sq. in.	9,000	5,000	4,000	1,000	3,400
Impact Strength (Dynstat)• kg. cm./sq. cm.	10.5	7.1	6.5	11.5	1.6
Refractive Index	1.490	1.485	1.484	1.483	1.477
Extensibility—5 mil films (percent at break)	4	7	5	230	2
Toughness△	98	174	76	1,000	23
Dielectric Strength—volts/mil. (thickness—0.05 in.)	740	....	650	625	....
Power Factor—percent at 25°C. and 60 cycles	6.5	....	3.8	6.2	....

*Gardner, "Physical and Chemical Examination of Paints, Varnishes, Lacquers, Colors". Eighth Edition, Page 300.

†Thermal yield point is not softening temperature. It designates the temperature to which a rod of the resin 3 in. by 3/8 in. by 3/16 in. can be heated before it will remain bent after a moderate mechanical stress has been applied. The softening temperature would be much higher. The methacrylate resins do not melt.

•*Instruments*, 9, 218 (1936).

△Area under load-elongation curves, expressed in arbitrary units.

creased due to the ease with which it may be worked. The material can be molded, and either the molded or cast form readily worked, sawed, cut, blanked, turned, drilled, formed, swaged, ground-polished, sanded, and routed similar to nitrocellulose plastics. Shaping of the polymethyl methacrylate resin sheeting can be accomplished when the sheeting becomes soft enough at about 105°C. (221°F.) When compound or deep curves are desired and the sheet must be stretched, temperatures up to 205°C. (400°F.) may be used. Air ovens to provide uniform heating is regarded as the best method of preparing the sheeting for shaping. Forms of wood, metal, or plaster are used and after the sheeting cools to 60-70°C., it will hold its shape on being released.

To cut the resin by sawing, a hollow-ground circular saw with no set, five teeth per inch, and peripheral speed of 9300-9500 ft. per min. is recommended for best results. A stream of water is sprayed on the saw to reduce chipping. Thick sheets of the resin are often chilled with carbon dioxide before sawing. Although softer than glass, the resin is more surface-resistant than many other thermoplastics and the original brilliance of a scratched surface can easily be restored by a simple and rapid polishing procedure.

The acrylic resins are in wide use as binders for wood, metal, textiles, rubber, glass, and other materials. Their use offers complete freedom from bacterial and fungous deterioration and affords a colorless transparent bond. In such instances where bonded assemblies are subject to flexure and elongation, use of the resin is permissible because of the elasticity and extensibility possessed.

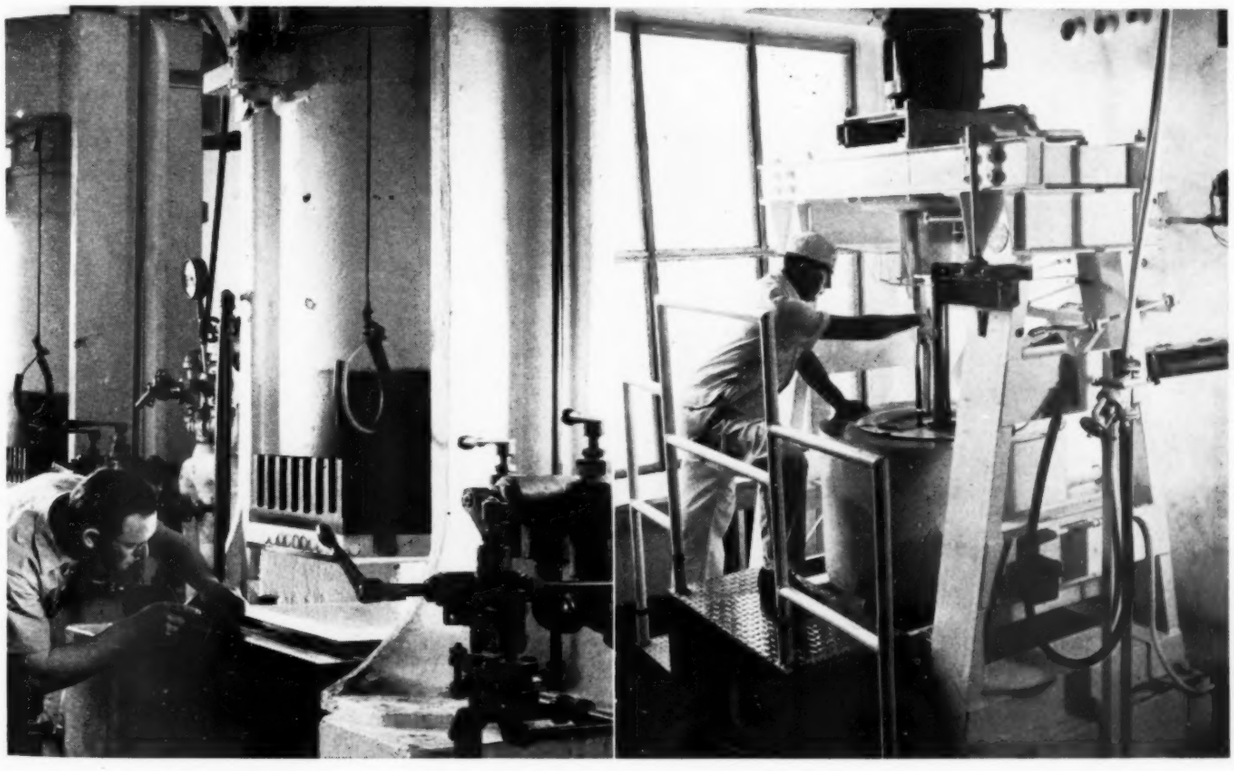
Automotive Industry

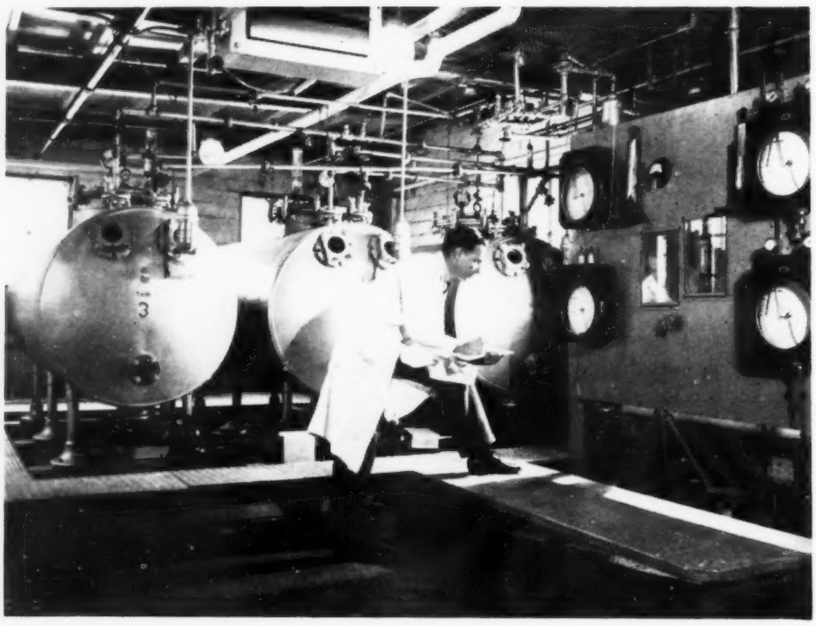
In the automotive industry the polymethyl methacrylic resin was the first plastic successfully used for exterior parts such as radiator ornaments and directional signal lenses whereas its unusual light carrying properties are responsible for a revolutionary departure in dashboard lighting affording a better night-time visibility. Approximately 14 of the 1941 car manufacturers employed the resin for a total of 39 different parts, many of which had formerly been made of metals that have since become essential in the Nation's production program.

The crystal clarity and weathering qualities make it suitable for lenses of gas-masks, industrial instruments lenses, and magnifying lenses. Its

A sheet from methyl methacrylate molding powder being removed from molding press

After polymerization the molding powder receives preliminary drying in centrifuge





Methyl methacrylate monomer after arriving by tank car from one plant is stored under specified conditions of temperature and pressure in a second plant

toughness and ease of working has resulted in its being used for parts of musical instruments, kitchenware, knives and other such utensils, combs, brushes, mirrors, costume jewelry, cigarette cases, and for many other applications. Molded panels in the doors and drawers of new electric refrigerators add visibility to the food-storage units and these panels are easy to keep clean.

Textile Industry

Aqueous dispersions of the acrylic polymers are used in the textile industry as permanent finishes, stiffening and increasing the tensile strength and wear resistance of the impregnated fabrics. No baking is necessary. The fabrics are wash-fast and possess stiffness and sheerness.

The dentistry profession has accorded a favorable reception to a denture material made of the resin. The material is readily pigmented to simulate the color of the mouth tissues and possesses the required toughness and resistance to water, acids, and alkalies, at the same time the temperature range necessary to form it in the plaster molds of dental laboratories does not restrict its use as it has other synthetic resins. Several special compositions have been developed from the resin for molding.

Aircraft Industry

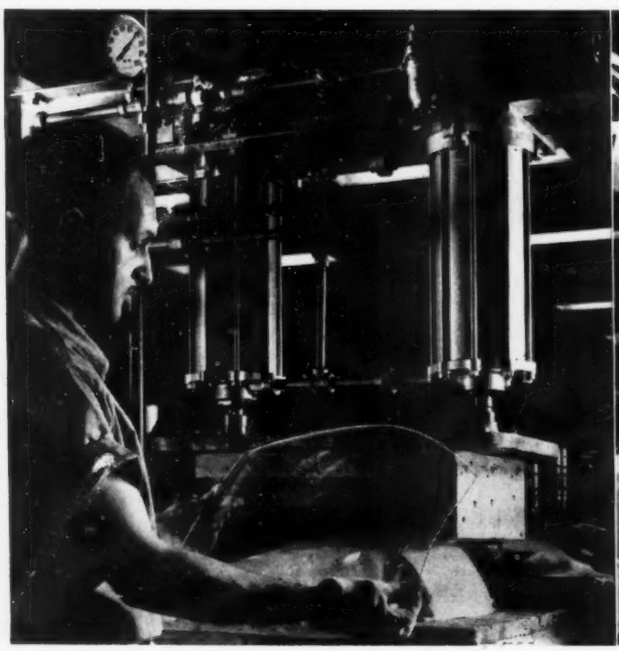
The aircraft industry has found sheets of polymethyl methacrylate well suited to its requirements, due to lightness, weathering characteristics, and clarity. This industry uses the resin for landing light covers, gun turrets, cockpit enclosures, and window and windshield applications.

The versatile applications of this plastic are too numerous to mention in detail. Hundreds of products are in daily use and the development of new ones marches constantly forward. It has been a little more than three years since use of the resins came into prominence and although this progress has been unusually rapid due to their wide acceptance in the fabrication field, it is expected that the pace will be greatly accelerated during the coming years.

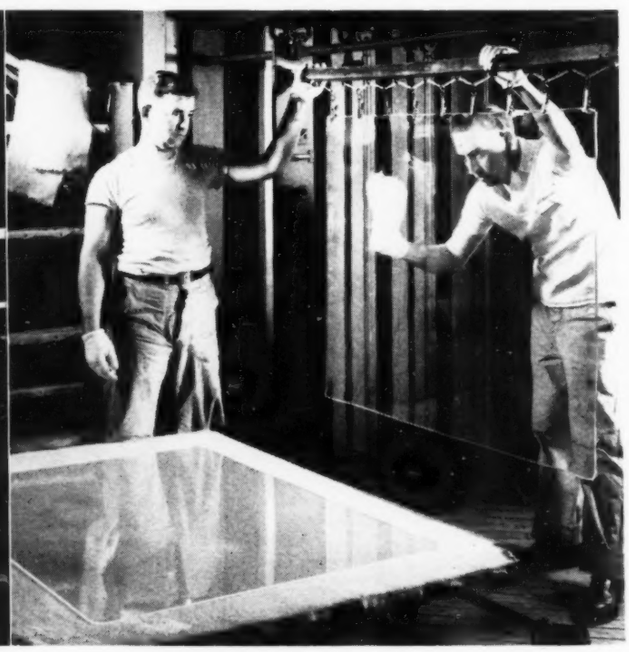
Material and photographs for this article supplied by E. I. du Pont de Nemours and Co., Inc.

☆ ☆ ☆

Formed sheets of this resin are used by the aircraft industry; the resin is thermoplastic and easily formed by heating to any shape



Large cast sheets of methyl methacrylate resin receiving inspection and polishing; it is to be used for aircraft turrets, cowlings, etc.



● For posting on bulletin boards and shop walls in Linde customers' plants, a two-color version of the poster shown above is available. These posters will remind your employees of the vital need for fullest utilization of existing stocks of oxygen and acetylene cylinders and will thus help assure your gas supply. Ask any Linde office for the quantity you require, specifying Form 5104.

THE LINDE AIR PRODUCTS COMPANY

Unit of Union Carbide and Carbon Corporation

30 East 42nd Street, New York, N.Y. UCC Offices in Other Principal Cities

In Canada: Dominion Oxygen Company, Limited, Toronto

LINDE OXYGEN . . . PREST-O-LITE ACETYLENE . . . UNION CARBIDE
OXWELD, PUROX, PREST-O-WELD APPARATUS . . . OXWELD SUPPLIES

The words "Linde," "Prest-O-Lite," "Union," "Oxweld," "Purox," and "Prest-O-Weld" are trade-marks of Units of Union Carbide and Carbon Corporation.

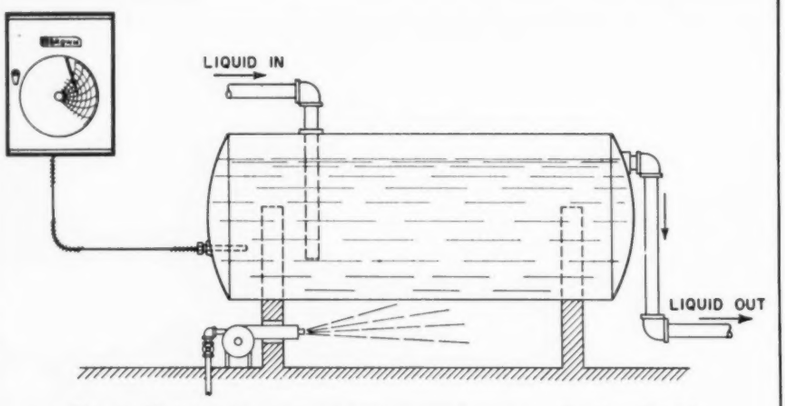


Fig. 1. Maintaining a constant temperature on a flowing liquid in vessel of large capacity

PETROLEUM ENGINEER Exclusive Feature

Technique of Precision Control in Refining Processes

☆ **Advancements in fractionating practice have increased the reliability placed on instruments and control equipment in the refinery**

by R. B. Werey

Manager, Petroleum and Chemical Division, The Brown Instrument Company

TODAY, as never before, emphasis is being placed on the need for more precise automatic control of all industrial processes. The demand for increased output, the shortage of skilled labor, and the rigid specifications of war-time production have made it necessary for the manufacturer to seek out every possible means of improving his production efforts.

The need is particularly urgent in the oil refining industry. The vast expansion program now under way to increase the output of high-octane fuel, butadiene for synthetic rubber, toluene, and other special products, involves processes requiring fractionation of mixture to purity standards previously not attempted. All preconceived ideas of product quality have had to be discarded because such methods called for fractionation of cuts with limited boiling ranges whereas today's standards are demanding separation into practically pure components. There is a vast difference in the technique required to separate practically pure toluene or pure *iso*butane from a three or four component mixture and that used in the everyday operation of making regular motor fuel.

Automatic control equipment has long been recognized as a prime essential in the successful operation of modern refining units, but the remarkable advances in fractionating practice have thrown an increasing responsibility on intruments and control equipment.

R. B. WEREY

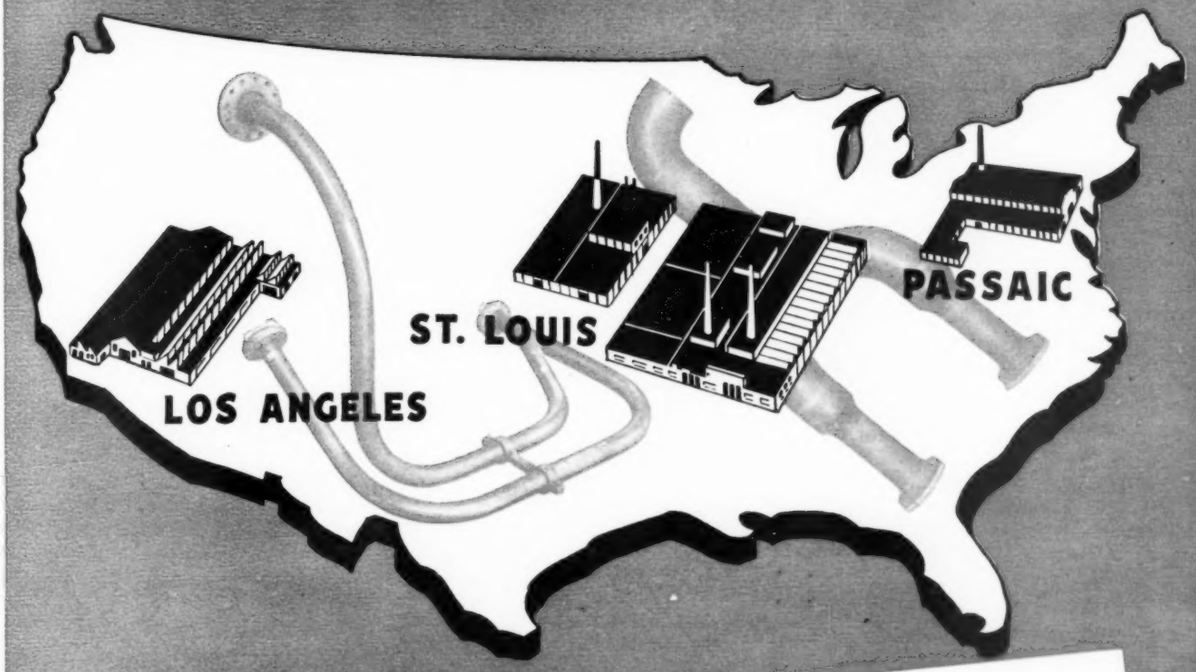
graduated from the University of Michigan in chemical engineering, 1921—Spent 9 years in the oil refining industry with Cities Service Company, and M. W. Kellogg and Company—For the last seven years has been with The Brown Instrument Company in charge of sales to the petroleum and chemical industries—Is a member of the American Institute of Chemical Engineers.

Refinery management and operating personnel have become increasingly conscious of the importance of good control engineering and have done much to advance the science by recognizing that control engineering is as much a part of process engineering as is the preparation of a heat balance. They have realized that it takes more than a good mechanic to instrument a precision fractionating unit properly just as it takes more than a good draftsman to design one. A thorough knowledge of instrument design is highly desirable and quite necessary as part of the qualifications of a good instrument man, but control engineering involves more than mere acquaintance with instrument details.

It is impractical to discuss precision control in refining processes without first outlining the fundamental factors that influence the proper selection and application of control equipment. To appreciate their significance one must draw upon his knowledge of the elementary physics of measurement, the kinetics of flow, and the rudiments of heat transfer.

Before we can control, we must first

MIDWEST PIPING SERVICE IS NATION-WIDE



Now . . . that Time is more vital than ever before . . . the strategic locations of the Midwest plants for the fabrication of piping take on added importance. Each Midwest plant is a complete unit . . . provided with the most modern equipment and manned by a highly skilled organization for prefabricating all kinds of power plant and process piping. You will find it definitely advantageous to get in touch with the nearest Midwest office whenever you need fabricated piping . . . whether only a simple pipe bend, a coil or a complete alloy piping job.

MIDWEST PIPING & SUPPLY COMPANY, Inc.

Main Office: 1450 So. Second St., St. Louis, Mo. • Plants: St. Louis, Passaic (N. J.) and Los Angeles

Sales Offices: Chicago—949 Marquette Bldg. • Houston—229 Shell Bldg. • Los Angeles—520 Anderson St. • New York—(Eastern Division) 30 Church St. • San Francisco—436 Call Bldg. • Tulsa—533 Mayo Bldg.

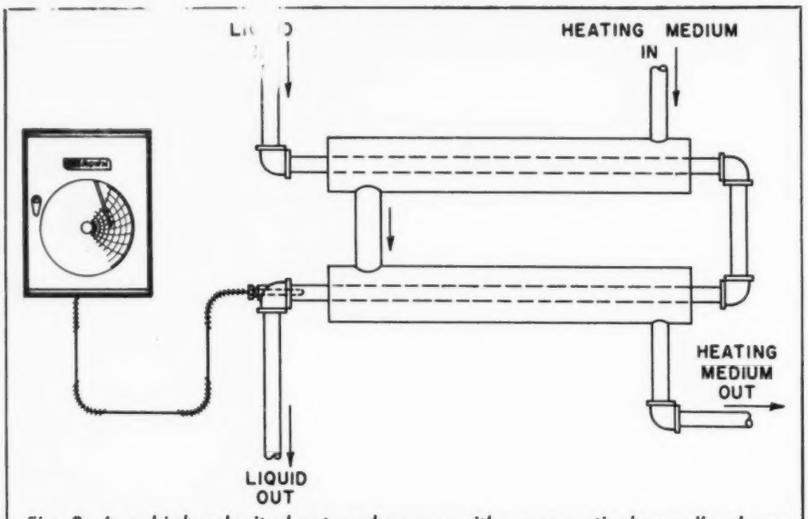


Fig. 2. In a high-velocity heat exchanger, with comparatively small volume of fluid in the tubes at any one time, rate of flow of the liquid is identical to that of the vessel shown in Fig. 1.

measure. This measurement, whether it be that of temperature, pressure, flow, liquid level, or any other function, must be a true criterion of the changes for which we wish to compensate. It is a comparatively simple matter to raise the temperature of a flowing fluid to a given value, but to maintain that value within close limits involves a delicate balance between heat input, heat losses, and heat absorption. The amount of heat absorbed will be influenced by rates of conductivity, radiation losses, changes in characteristics of the flowing medium, atmospheric temperature changes, and many other factors dependent entirely upon the particular problem in hand.

Economy

One of the underlying reasons for the increase in the use of automatic control equipment in the oil refining industry is the present tendency to eliminate, whenever possible, every extra cubic foot of vessel storage capacity. With the increased demand for oil products, the economics of the situation have demanded larger and more flexible distillation units, with lower initial cost and lower operating cost per barrel of throughput. This has been accomplished first by reduction in size and volume of the vessels for any given throughput, and second, by the design of heat transfer equipment with greater operating efficiencies. The advances that have been made in the industry in the last ten years are so great that any comparison of present-day practice with that of previous years appears at first sight to be gross exaggeration. By stepping-up fluid velocities, improving heat transfer rates, and decreasing stored liquid capacities, the plants of today are seemingly no larger in physical size than those of ten years ago, even though their capacity may be double that of the older units.

In order to obtain a clearer concept of the effect of these factors on the problem of automatic control, we would do well to analyze certain characteristics of heat transfer media and observe their influence on the control problem.

Storage Capacity

In any process, whether it be batch, semi-continuous, or continuous, storage capacity, either as fluid volume or heat content, constitutes the equivalent of a balance wheel in its tendency to keep the system in equilibrium. Although large fluid or heat storage capacities may introduce lags that would tend to be unfavorable to control, the predominant effect of all storage capacity is favorable. Its favorable effect becomes more pronounced as the rate of heat input approaches the rate at which the mass, either solid or liquid, absorbs this heat; or, stated conversely, it can tend to become an unfavorable factor if the rate of heat input exceeds the rate of heat absorption.

As a comparison between large and limited storage capacity, consider the difference between holding a constant temperature on a flowing liquid as illustrated in Fig. 1, and that of holding a constant temperature on a flowing liquid as illustrated in Fig. 2.

In Fig. 1 we have a fixed volume flowing into the vessel and an equivalent volume flowing out. Heat is applied to the vessel containing a considerable volume of the liquid and the temperature is measured by a thermometer bulb placed in the liquid.

In Fig. 2 we have substituted in place of the vessel a high-velocity heat exchanger, with a comparatively small volume of fluid in the tubes at any one time. Rates of flow of the liquid are identical to those of Fig. 1.

Several things are obvious in studying these two illustrations. In Fig. 1 it is evident that slight changes in rate of flow, uneven firing of the vessel, or sudden changes in atmospheric conditions will not seriously affect the controlled temperature. The mass of liquid exerts a stabilizing influence on the system and will tend to decrease variations caused by any of these changes. In the case of Fig. 2, however, no such stabilizing influence is available. The total volume of liquid in the exchanger at any moment is small in comparison to the rate of throughput. Slight variations, either in rate of feed or rate of heat supply, will be reflected immediately in the temperature-measuring instrument, requiring constant vigilance on the part of the attendant to hold temperatures in such a system constant.

Process Time Lags

Of equal importance in its effect on the controllability of a system is the matter of process time lags. The word "lag" implies a time factor and can be defined as the time interval that elapses between a load change and the time that its effect is felt at the sensitive element. Generally speaking, the shorter the time lag, the simpler the problem of control. It is not to be inferred, however, that a problem with a minimum of process lag can always be solved with the simplest type of control mechanism, because lags must be weighed with capacity and other effects described later. A few examples of process time lags will be illustrated and described.

One of the simplest cases is illustrated in Fig. 3, which shows a common design of steam-jacketed vessel used for heating services in many industries. If such a vessel is used without some mechanical means of keeping the liquid in motion, such as a stirring device, it is evident that heat is transferred from the steam jacket to the center of the vessel by conduction only. By using a stirring device, the rate of heat input is accelerated by the additive effect of convection heat transfer. The actual time lag in transferring heat to the center of the mass will be dependent on (a) the conductivity of the liquid, (b) the rate of stirring, (c) the amount of heating surface in relation to the mass of liquid being heated, (d) the temperature differential between the steam and the liquid, (e) cleanliness of the vessel surface, sometimes termed "fouling" factor, and several other factors of equal importance.

BROWN CONTROLLERS for NARROW BOILING RANGE COLUMNS

TOWER TEMPERATURE CONTROLLER

TOWER PRESSURE CONTROLLER

REBOILER FLOW AND LEVEL CONTROLLER

PRECISION CONTROL of Narrow Boiling Range Columns is obtained only by experienced control engineering and proper application of control instruments.

Each and every control problem, whether it be tower temperature—tower pressure—or any one of a number of other process variables, must be carefully analyzed and coordinated in order to obtain stable tower operation and high quality of product.

Leading refiners have found it advantageous to rely on Brown engineers to recommend the proper instruments and the most effective coordinated control system.

For accurate control of critical tower temperature, the new Brown Circular Chart *"Continuous Balance"* air-operated Potentiometer has been acclaimed as the ideal controller. This instrument employs no galvanometer, but uses instead a *"Continuous Balance"* Unit consisting of a Conversion Stage and Amplifier.

Brown *Air-o-Line* Controllers fulfill every requirement for "speeding up" the Oil Industry's "All Out" program.

Begin now to get the many benefits of Brown and Minneapolis-Honeywell Nation-wide Engineering Service. Write for details.

BROWN *Air-o-Line* CONTROLLERS

THE BROWN INSTRUMENT COMPANY, 4475 WAYNE AVENUE, PHILADELPHIA, PENNSYLVANIA
DIVISION OF MINNEAPOLIS-HONEYWELL REGULATOR CO.
MINNEAPOLIS, MINNESOTA AND 119 PETER STREET, TORONTO, CANADA
Wadsworth Road, Perivale, Middlesex, England
Nybrokajen 7, Stockholm, Sweden

It is obvious that some of these lags can be reduced by having the mass of the liquid small in relation to the amount of heating surface. In so doing, however, the stabilizing effect of stored heat capacity is lost.

A standard tubular type countercurrent heat exchanger is a good example of a heating system with a high rate of heat input, but with small storage capacity. The factors influencing the amount of time lag in such a heater are essentially the same as those outlined, namely: (a) the conductivity of the liquid, (b) temperature differential between heating medium and liquid, (c) conductivity of the heat exchanger materials, (d) velocity of flows of both mediums and other factors peculiar to the particular design of the equipment. In general, the time lags will be smaller in this type of equipment than in those shown in Fig. 3.

Still another type of lag is illustrated in Fig. 4, showing a tubular type of furnace used in the refining industry. Oil is pumped from a storage vessel through this heater at a constant rate of flow. The heater contains hundreds of feet of tubing, and flow is generally in series, with a maximum velocity of 6 to 12 ft. per sec. Regardless of the actual velocity, it still requires an appreciable time for a molecule of oil to pass through the heater. If we were to assume an ideal condition in which every ordinary variable, except the inlet temperature, were for the moment constant, it is evident that there would be a lag in the recording of an inlet temperature change if the bulb or thermocouple were placed in the outlet line. If we are controlling the outlet temperature, we must necessarily wait for an indication of this change in inlet temperature before we can begin balancing the control system to new load conditions.

Thermal Potentials

Another factor that must be considered simultaneously with capacity effects and process lags is the rate of heat transfer. The use of higher thermal potentials is an important factor in reducing the size of heat transfer equipment, inasmuch as the rate of heat transfer from one medium to another is proportional to the thermal differential. In other words, we can heat a liquid faster by subjecting the vessel to flame temperature than we can by heating with a steam jacket as shown in Fig. 3.

In such cases, the material being heated must move at high velocity to prevent burning or scorching and this means that such heating should be done with tubular or pipe coil heaters. There is generaly a reduction of lags in such systems, but the gain made is generally offset by the reduction in heat storage capacity. All other factors being equal, it can be stated that the greater the thermal potential between supply and demand, the more difficult the control problem. As a corollary, it can be said that similar effects are obtained by having the control valve considerably oversized. In either case, the problem resolves itself into one of extremely accurate positioning of the control valve to accommodate a specific load change.

It is well that we pause for a moment to consider the significance of rate in its application to the science of automatic control. We have already used the word several times in discussing rate of heat transfer, rate of load change, and rate of heat input.

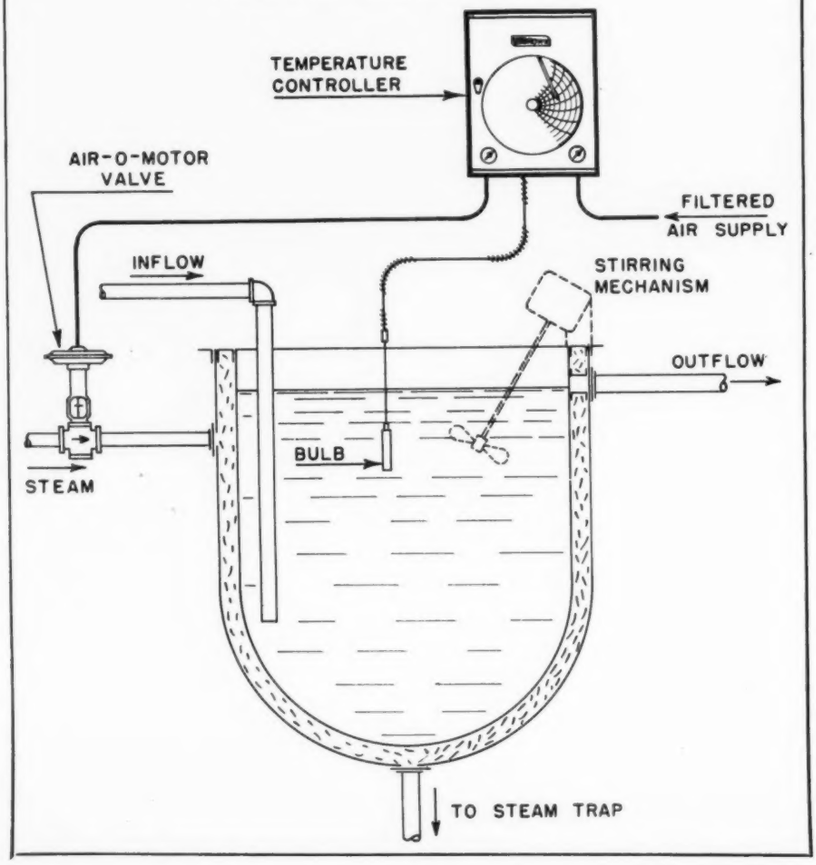
Rate can be defined as the change in magnitude per unit of time. Process lags involve a time factor and are to a degree a measure of the rate of heat transfer. Every process, whether it be heat-treating, cooking, or distilling, has a rate at which it comes to equilibrium when a new rate of heating or cooling medium is applied. It has been shown that these rates are a function of several factors, depending entirely upon the problem and the type of heat transfer equipment used. They are dependent on the mass or capacity of the system, on the thermal potentials used in heating or cooling, on the conductivity of the metals or materials used in the heat transfer equipment, and on many similar factors. In general, they are independent of the magnitude of load changes.

The significant thing to bear in mind is that proper adjustment or "tuning in" of controllers or control systems is accomplished by synchronizing the rate of valve opening (rate of heat input) with the rate of heat absorption. The mechanical means employed to obtain this synchronization is termed: (1) Throttling Range Adjustment, and (2) Rate of Automatic Reset. Both of these functions are incorporated as component parts of modern, high-grade, air-operated controllers. For precision control of complex processes, only controllers fitted with these two adjustments should be used.

Narrow Boiling Range Columns

Heading the list of "tough" problems in the oil industry, those demanding the utmost in precision control, are the fractionation units now being built for the separation of relatively pure products from a variety of feed stocks. In some cases, these feed stocks may be two component mixtures with

Fig. 3. Steam-jacketed cooking vessel



Deep in the heart of the active fields

Whenever you need anything in the line of supplies or equipment, from wrenches or safety helmets to pumping units, it pays to get it at the trim, up-to-the-minute Bethlehem Supply store near you.

In the Bethlehem Supply store you'll find a wide range of top-quality products of well-known manufacture. And you'll find a group of field managers, salesmen and engineers with useful oil-country knowledge, ready and eager to give you a hand with your field problems.

Even if you don't happen to need anything at the moment, next time you see a Bethlehem Supply store drop in anyway. The men of Bethlehem Supply will be glad to welcome you. Come in and get acquainted!

CALL **BETHLEHEM SUPPLY COMPANY** FOR SERVICE

BETHLEHEM STEEL

Offices or Stores—*Illinois*: Grayville, Salem, St. Elmo; *Indiana*: New Harmony; *Kansas*: Chase, Great Bend, Russell, Wichita; *Louisiana*: Harvey, Houma, Lake Charles, New Iberia, Shreveport; *New Mexico*: Artesia, Hobbs; *Oklahoma*: Fittstown, Oklahoma City, Seminole, Tulsa, Wewoka; *Texas*: Alice, Borger, Corpus Christi, Dallas, Fort Worth, Freer, Houston, Kemp City, Kilgore, La Ward, Midland, Odessa, Pampa, San Antonio, Seminole, Sundown, Wichita Falls.

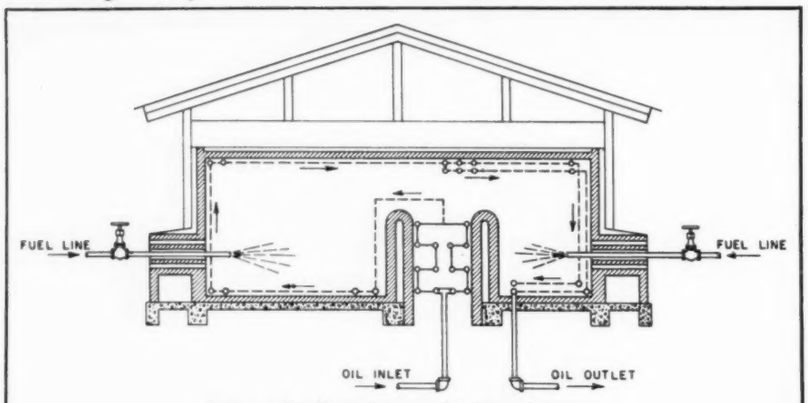


Fig. 4. Radiant heat reforming furnace

as little as 2 to 4 percent impurities. The difference in boiling points of the individual components is generally small, such as in the separation of *iso*-butane from normal butane when the difference in temperature between the top and bottom of the tower may be as low as 25°F. or 30°F. Generally these fractionating columns will have a larger number of trays than the conventional column, with a proportionate increase in height. In some instances, columns with 80 to 85 trays have been used.

Now a fractionating column is merely a heat exchanger in which heat is absorbed and given up through condensation and evaporation. Vapor velocities cannot be increased beyond certain predetermined limits without a sacrifice in fractionating efficiency. Consequently, the rate at which such columns come to equilibrium after a load change or disturbance in the system, is extremely slow. The extreme lags encountered in such towers, coupled with their extreme sensitivity to small increments of load change, make the entire system one which requires most careful consideration when it comes to selection of control equipment.

Generally speaking, there are seven independent variables in such systems (refer to Fig. 5), six of which should be controlled, leaving the seventh, composition change, uncontrolled. These variables can be itemized as follows:

(1) Tower temperature control
(2) Tower pressure control
(3) Rate of feed to tower
(4) Temperature of the feed
(5) Rate of reflux
(6) Rate of outflow from tower
(7) Composition of the feed.

Tower Temperature Control

Although it is conceded that the degree of perfection attained in the control of the tower temperature is the criterion for determining the effectiveness of the entire control system, we must be careful not to impose too heavy a duty on this instrument if real stability of operation is desired. As previously stated, these towers are extremely sensitive to small increments of load change. The equilibrium of the entire system can be easily disturbed by minute changes in feed temperature, changes in rate of feed, changes in tower pressure, changes in feed composition, changes in atmospheric temperatures, and several other variables.

It must be borne in mind that the tower temperature controller can make no corrections for any of these variables until after the effect of the change is felt at the sensitive element of the controller. Conceivably it might take five, ten, or even fifteen minutes for a change in reboiler steam pressure on the upstream side of the control valve to make itself felt to the temperature controller. A slight change in rate of feed could cause effects almost as bad. Furthermore, it will take equally long to make corrections once the effect of the changes has been sensed.

The real criterion for determining how much the system is adversely affected by such changes is the rate of change of these variables. If the rates of change can be held down to values smaller (slower) than the rate at which the tower system can absorb them, the problem of control is simplified. Regardless of the rate of change, however, it is necessary to provide the proper control equipment to minimize the effect of such variations. Only when this has been accomplished will it be possible to take full advantage of the inherent accuracy and sensitivity of modern potentiometer-type temperature controllers when fitted with ranges of narrow span.

Placing the Control Bulb

In the separation of a two-component mixture, it is not practicable to place the control bulb at either the bottom or top of the column. At these points, the products are approaching relative purity and the theoretical separation curves show that there is only a slight change in the boiling temperature for an appreciable change in composition. The bulb or thermocouple must, therefore, be placed at that point in the column where a minimum change in composition causes a maximum change in temperature.

The determination of this point will vary with the percentage composition of the feed. Consequently it is a control point for one given feed composition only and theoretically should be shifted for every composition change. As this is obviously impracticable, it is well to reduce this particular variable to a minimum. A change in composition demands a change in reflux rate, but as there is no commercial apparatus available for continuously determining changes in composition, it is impracticable to interlock or proportion the reflux rate with changes in feed composition. If feed composition does vary, rate of variation should be no faster than the rate at which the tower system comes to equilibrium. In some instances, the only manner in which this problem can be solved is by the introduction of a mixing vessel in the line with sufficient capacity to iron out major variations.

The actual position of the sensitive element of the temperature controller must be determined from laboratory data correlated with tower design. Inasmuch as it is difficult to predetermine the exact point of maximum sensitivity, it is advisable to fit the tower with several thermocouple wells in the region selected so that the couple can be shifted while the unit is in operation.

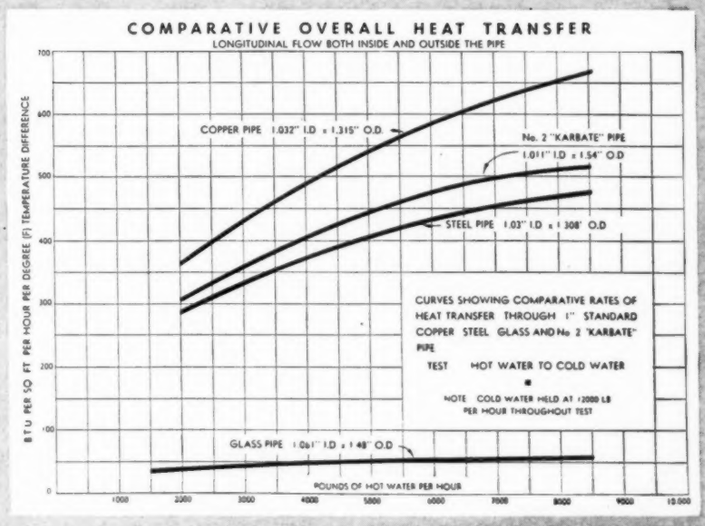
In connection with the recommendation that the effect of such variations be minimized, the reader is referred to the flow sheet in which the tower temperature controller is shown interlocked with a rate of flow controller on the steam line to the reboiler. With such an arrangement, variations in main line steam pressure are caught before they have had time to affect the system; in addition, it provides a means of metering the heat input in exact accordance with the load requirements.

Tower Pressure Control

Of equal importance in obtaining coördinated control in columns of narrow boiling range is the tower pressure controller. Control can be obtained in several ways, either by throttling cooling water to a total condenser or by fixing the rate of cooling water and throttling the outlet condensate line in order to flood the tube bundle. Either method introduces a serious time lag between a change in valve position and the time that its effect is felt at the instrument.

Karbate No. 2 Pipe and Fittings

TRADE-MARK


COMPARATIVE OVERALL HEAT TRANSFER
LONGITUDINAL FLOW BOTH INSIDE AND OUTSIDE THE PIPE
B T U PER SQ FT PER HOUR PER DEGREE (F) TEMPERATURE DIFFERENCE
COPPER PIPE 1.032" I.D. x 1.315" O.D.
No. 2 "KARBATE" PIPE 1.011" I.D. x 1.54" O.D.
STEEL PIPE 1.03" I.D. x 1.308" O.D.
GLASS PIPE 1.061" I.D. x 1.48" O.D.
CURVES SHOWING COMPARATIVE RATES OF HEAT TRANSFER THROUGH 1" STANDARD COPPER STEEL GLASS AND No. 2 "KARBATE" PIPE
TEST HOT WATER TO COLD WATER
NOTE COLD WATER HELD AT 12000 LB PER HOUR THROUGHOUT TEST
POUNDS OF HOT WATER PER HOUR

Offer High Rate of Heat Transfer

RESISTANCE TO CORROSION

RESISTANCE TO THERMAL SHOCK

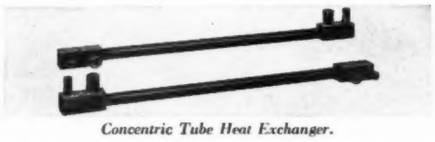
for the construction of HEAT EXCHANGE EQUIPMENT

● The high heat transfer characteristics of "Karbate" No. 2 Pipe and Fittings are ideal for heat exchange applications. The curves above show the comparative rate of heat transfer through standard 1" glass, steel, copper and "Karbate" No. 2 pipe.

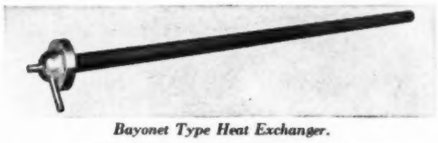
"Karbate" heat exchangers are especially applicable under conditions of severe thermal shock and corrosion. They are inert to the action of most acids and alkalies and are not affected by salt water. They will not fracture, chip or spall under severe temperature change. Practically any type of heat exchange equipment can be constructed of "Karbate" Pipe and Fittings. Examples of several representative types of heaters and coolers are shown on this page. Hundreds of such units, varying greatly in size and design, are now being used with success in industry.

Complete systems of "Karbate" Pipe and Fittings for conveying and handling corrosive materials have been installed in many plants.

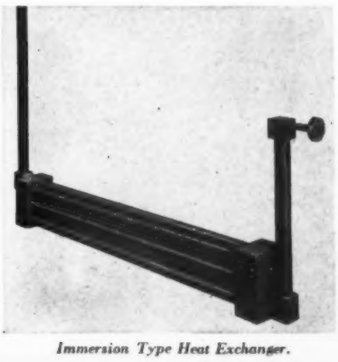
WRITE FOR YOUR COPY OF OUR NEW BOOKLET ON PIPE AND FITTINGS



Concentric Tube Heat Exchanger.



Bayonet Type Heat Exchanger.



Immersion Type Heat Exchanger.

Return Bend Cooling Coil.

Elements for Shell Tube Type Heat Exchanger.

NATIONAL CARBON COMPANY, INC.

Unit of Union Carbide and Carbon Corporation

UCC

Carbon Sales Division, Cleveland, Ohio

General Offices: 30 E. 42nd St., New York, N. Y.

Branch Sales Offices: NEW YORK, PITTSBURGH, CHICAGO, ST. LOUIS, SAN FRANCISCO

If the cooling water flow is throttled, it is desirable to interlock a rate of flow controller on the water line with the pressure controller in order to reduce to zero the effect of changes in water rates due to changes in pressure differential across the control valve. The need for the interlocked flow controller can be readily appreciated by studying the records of the average plant water pressure for a period of 24 hours. Unless the water is supplied from a separate pumping system, the records in most plants will invariably show variations great enough to cause momentary upsets in the control system if the pressure controller operates the control valve directly.

By installing a diaphragm or butterfly valve directly in the overhead vapor line, it is possible to obtain good control with a minimum of time lag. Control valves are always relatively large and costly and sometimes difficult to obtain for this system of control, however.

Tower Feed Control

There is no substitute for a rate of flow controller on the tower feed line in precise fractionating columns. Absolutely constant rate of charge to the tower is a prerequisite for stable control. When it is necessary to consider feeding directly from a preceding tower that has little liquid storage capacity to take up the surges in the system, it is advisable to shift the control of the level in the storage vessel from the outflow line to the inflow line and install a rate of flow controller on the outflow line (feed to the next tower). If this cannot be done, then an intermediate storage tank should be considered, or else the level of the tower can be controlled manually by resetting the rate of feed controller and observing the tower gauge glasses.

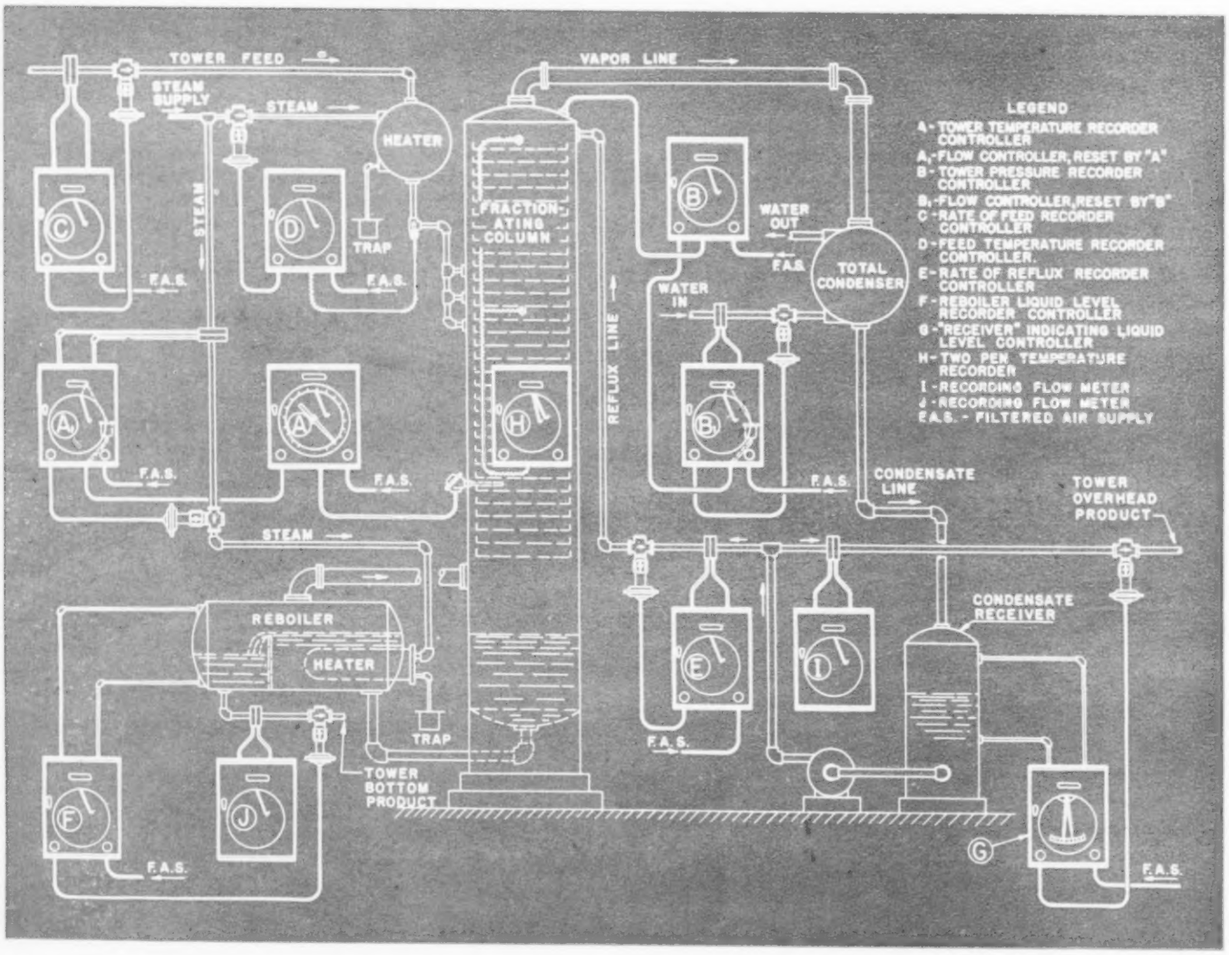
Other Applications

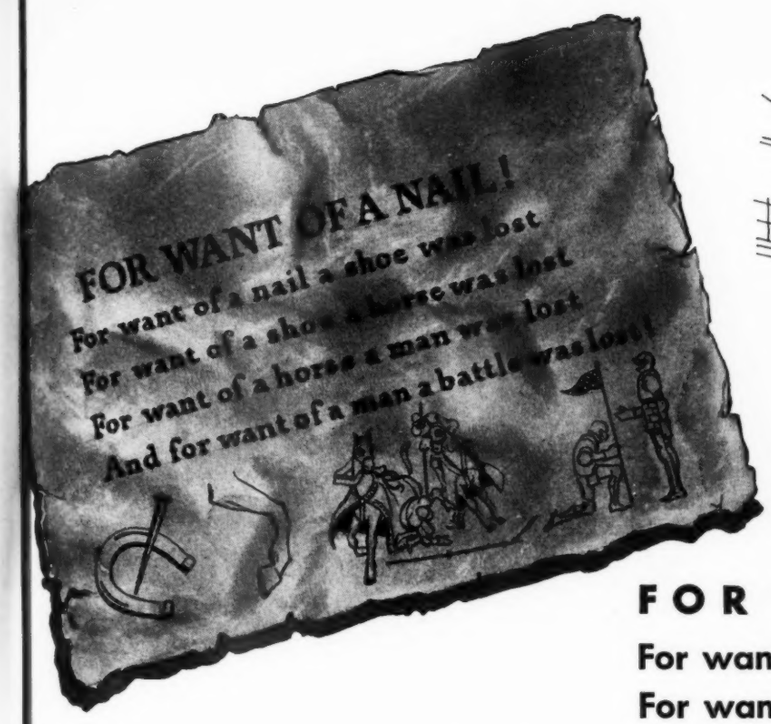
No article of this length can adequately cover in detail the many applications of precision control equipment encountered in the oil refining industry. Each process and each refinery has problems peculiar to its individual needs. Admittedly, also, there exists more than one method of accomplishing the same results in any individual case.

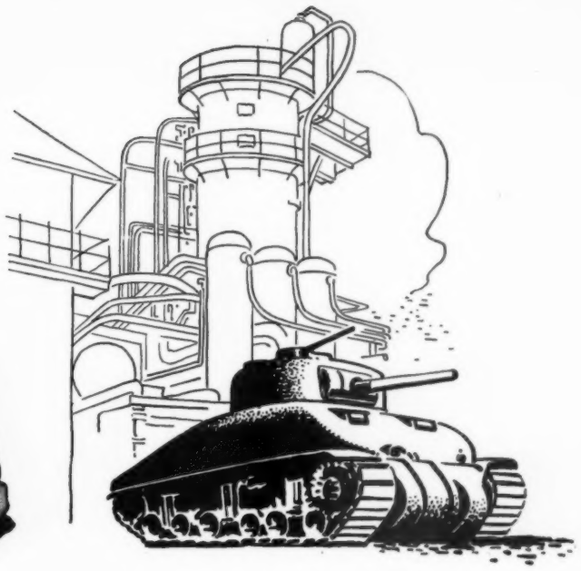
There is, however, one correct way to approach the problem and analyze control requirements. That method calls for the following: (a) an analysis of the storage capacity of the system, either in fluid or heat content, (b) a correlation of this capacity with the rates of load changes, (c) a study of the actual or potential process lags, and (d) careful consideration of the limits of any individual piece of control equipment selected for the job. Emphasis is placed on the word limits because too often the designer has made the error of assuming that one controller is capable of correcting for innumerable variables without regard for rates of variation or process lags. A broader comprehension of the technique of automatic control is always gained by the simple expedient of observing the limitations, as well as the possibilities, of controllers or control systems. Such an analysis is sure to disclose many ways of simplifying the control problem, reducing initial costs, and, in general, improving the operation of the units on which the instruments are installed.

☆ ☆ ☆

Fig. 5. Brown system for control of narrow cuts in fractionating columns




FOR WANT OF A NAIL!
For want of a nail a shoe was lost
For want of a shoe a horse was lost
For want of a horse a man was lost
And for want of a man a battle was lost!



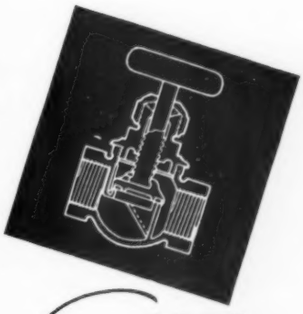
FOR WANT OF A VALVE

For want of a valve some steam was lost
For want of the steam some oil was lost
For want of the oil a tank was lost
For want of a tank an army was lost!

THAT rhyme is just another way to say that it now has become imperative that valves—particularly the valves *you* use—be maintained at the peak of efficiency.

Ordinarily that might mean replacement of many valves. But today valve metals are on the critical list. It has become un-American to replace valves that can be restored through repair or replacement of parts. And it is true Americanism to revert to old time thrift when checking the conditions of each valve and *"use it, mend it, make it do."*

As a matter of fact, Pratt & Cady by their invention of the Globe Valve with renewable seat and disc made this possible. You *can* renew your valves by first, resurfacing disc and seat—or wedge and seat—to a new seal. Then, when they are completely worn out, replace only these smaller parts. To be sure, the delivery of seats and discs is also subject to government regulations, making it good business to check the condition of your valves in plenty of time.



1885
Taken from one of the original Pratt & Cady Globe Valve patent drawings

READING-PRATT & CADY
READING, PENNSYLVANIA

A Division of AMERICAN CHAIN & CABLE COMPANY, INC. Bridgeport, Conn.

Synthesis of Known Hydrocarbons in Petroleum

☆ Discussion of the most satisfactory methods of synthesizing the various hydrocarbons present in petroleum

by W. L. Faith

Head, Department of Chemical Engineering, Kansas State College

THE petroleum industry is at present undergoing a comparatively rapid transition from a process industry into a highly technical organic chemical industry. In the future, emphasis will not be placed upon complex mixtures of hydrocarbons but upon simpler mixtures of fewer hydrocarbons or upon the individual hydrocarbons themselves. Over a period of years research chemists have isolated individual hydrocarbons from various fractions of petroleum, but it has been only recently that an orderly examination of the constituents of petroleum has been initiated. This work has been under the supervision of F. D. Rossini of the U. S. National Bureau of Standards, and has been known as A.P.I. Research Project No. 6. To date Rossini and his co-workers have isolated and identified 61 individual hydrocarbons from the gasoline and kerosine fractions of a Mid-Continent petroleum.[26, 27, 28]

The purpose of this article is to review the most satisfactory methods of synthesizing the various hydrocarbons known to be present in petroleum. It is hoped that such a review will be helpful to petroleum chemists interested in preparing these hydrocarbons in a pure form for studies of their properties. It is also possible that engineers may be interested in adapting some of the principles set forth to the manufacture of commercially pure hydrocarbons on a large scale.

Paraffin Hydrocarbons

The most common methods of synthesizing the paraffinic or saturated aliphatic hydrocarbons are: (1) condensation of two molecules of alkyl halides with sodium (Wurtz reaction); (2) reduction of the corresponding aldehyde or ketone with amalgamated zinc and hydrochloric acid (Clemmensen reaction); (3) hydrolysis of alkyl magnesium halides (Grignard reaction); (4) electrolytic reduction of ketones and esters; (5) catalytic hydrogenation of olefins, which may be prepared by the dehydration of alcohols.

W. L. FAITH

received a B.S. degree in industrial chemistry from the University of Maryland in 1928; an M.S. degree in chemical engineering from the University of Illinois in 1929, and a Ph.D. degree in chemical engineering from the University of Illinois in 1932—Associated at various times from 1926 to 1933 with U. S. Industrial Chemical Company, Baltimore, Maryland, National Aluminate Corporation, Chicago, Illinois, and Engineering Experiment Station, University of Illinois—Joined chemical engineering staff of Kansas State College in 1933 and became head of Department of Chemical Engineering in 1940.

The proper methods to choose for the synthesis of a particular hydrocarbon depends upon several factors, the most important of which are availability of raw materials, reaction yield, ease of separation of product from reaction mixture, and avoidance of rearrangements or isomerization. In practically all cases, a pure product is obtained only when the products of each step are carefully purified, and an efficient fractionating column is available for final purification of the product. The necessity for adequate fractionation equipment cannot be overemphasized, and possession of such equipment is the most important prerequisite for the successful synthesis of pure hydrocarbons.

Methane, ethane, and propane. The first three hydrocarbons in the paraffin series are obtained in large quantities by the fractionation of natural gas and cracking still gas. Accordingly, methods for their synthesis are comparatively unimportant. The laboratory preparation of methane is usually either the hydrolysis of aluminum carbide,[43]

$$Al_4C_3 + 12H_2O \longrightarrow 3CH_4 + 4Al(OH)_3$$

or the hydrolysis of the proper Grignard reagent,[43]

$$CH_3MgX + H_2O \longrightarrow CH_4 + MgX(OH)$$

Ethane and propane are usually prepared either by the Grignard reaction, or by the action of a zinc-copper couple on ethyl iodide and propyl iodide, respectively.[18]

$$Zn(Cu) + C_2H_5I \text{ or } C_3H_7I \longrightarrow ZnI + C_2H_6 \text{ or } C_3H_8$$

According to Whitmore,[43] the best method of preparing ethane is by the catalytic hydrogenation of ethylene prepared from ethanol.

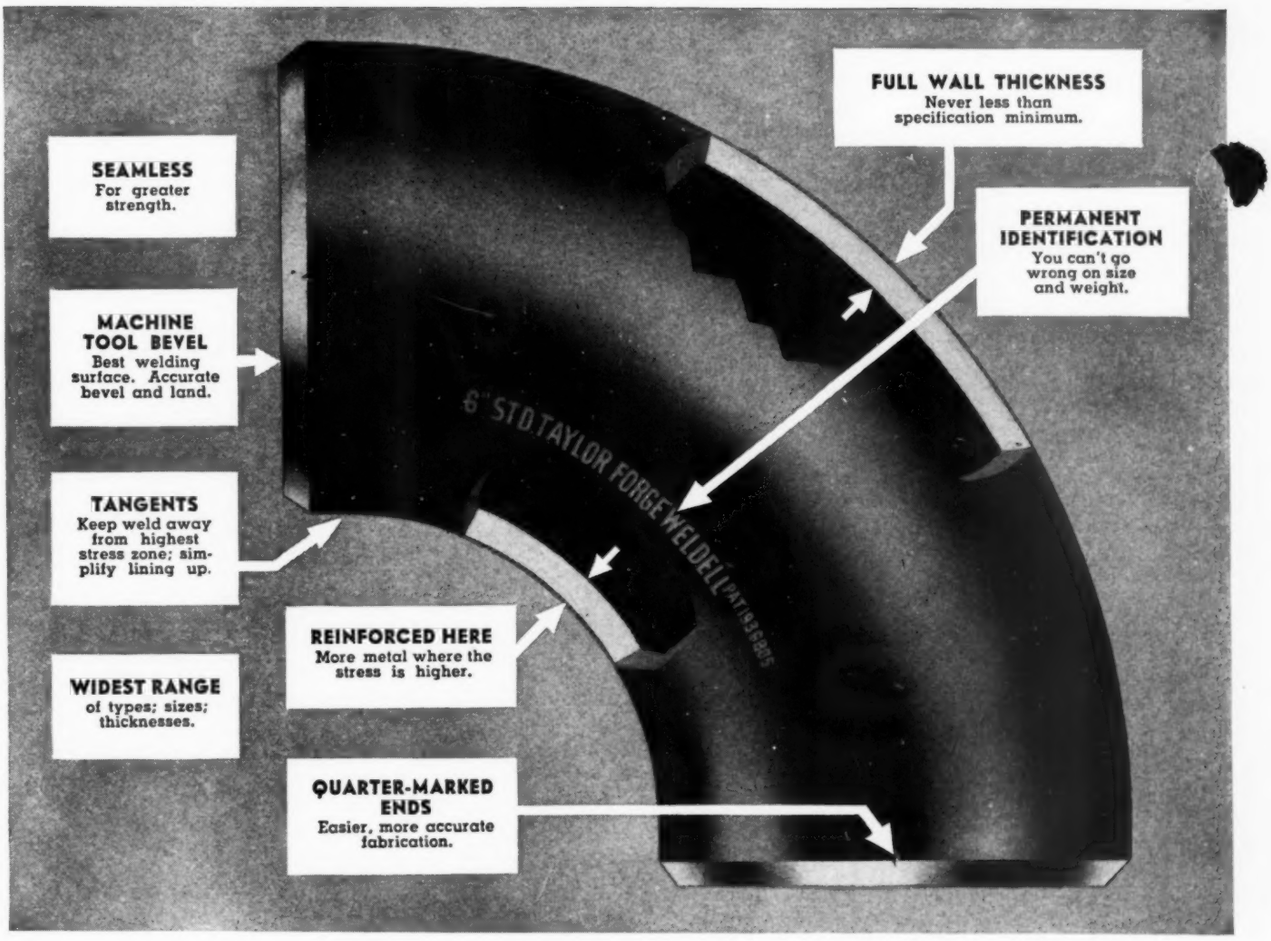
Higher paraffins. The most generally preferred method for the preparation of fairly large quantities of pure hydrocarbons above propane is the alcohol-olefin-paraffin method. This method, or slight modifications of it, has been utilized in preparing 22 of the 28 paraffin hydrocarbons isolated by Rossini. It consists of three general steps:

1. Preparation or purification of the proper alcohol.
2. Dehydration of the alcohol to an olefin.
3. Catalytic hydrogenation of the olefin to a paraffin.

This method is usually chosen for several reasons, i.e., the alcohols may either be prepared in a pure form by well-known methods or may be obtained commercially and purified rather easily; the products of each step may be rigorously purified; the last two steps are simple and well worked out; conditions are such as to minimize rearrangement or isomerization.

A typical example of this type of reaction is the preparation of 2-methylhexane.[12]

(a) N-butyl magnesium bromide in anhydrous ether and acetone is pre-


SEAMLESS
For greater strength.
MACHINE TOOL BEVEL
Best welding surface. Accurate bevel and land.
TANGENTS
Keep weld away from highest stress zone; simplify lining up.
WIDEST RANGE
of types; sizes; thicknesses.
FULL WALL THICKNESS
Never less than specification minimum.
PERMANENT IDENTIFICATION
You can't go wrong on size and weight.
REINFORCED HERE
More metal where the stress is higher.
QUARTER-MARKED ENDS
Easier, more accurate fabrication.
6" STD TAYLOR FORGE WELDELL PAT'D 6825

These features of WeldELLS

mean more than ever now

WHEN purchases are restricted to essential uses — uses, in other words, that contribute to winning a war that *must* be won — then, surely, is the time of times to *know what you're getting.*

So once more we show you here, in boiled down, quick-reading form, the facts about WeldELLS — the eight features of WeldELLS that contributes *something* to every pipe welding job — in ease of installation, in economy, in speed, in safety, in soundness, in the lasting satisfaction that goes with using the *best.*

If your requirement is vital enough to rate a preference, it is vital enough to rate the finest — particularly when the finest *costs no more.* Busy though we are, we want to sell you welding fittings at their best — and so do our distributors.

TAYLOR FORGE & PIPE WORKS, *General Offices & Works:* Chicago, P.O. Box 485
New York Office: 50 Church Street • *Philadelphia Office:* Broad Street Station Building

SPIN THE WHEELS OF INDUSTRY TOWARD THE VICTORY THAT IS OURS TOMORROW!

There should be no doubt . . . no questioning . . . the outcome of this war. America MUST win. She WILL win!

Of great encouragement is the fact that America has put her shoulder to the wheel, her heart to the task, and now the wheels of industry spin faster, faster, and faster.

We are proud to be among the hundreds of privately owned and operated Utility Electric Power Companies supplying power for defense industry. Of chief importance, of course, is that network of power flowing steadily to the petroleum industry.

By rigid conservation of critical materials and helpful counsel to consumers, we are able to meet the increased demand for electric power and at the same time maintain our same high standard of service to you.

Help us in every way you can to conserve electric power. Ask at your electric power company how to get the most service at the least cost for your power dollars. Let's help the wheels of industry spin faster, faster, and faster!

PROFIT! Utility ELECTRIC POWER

Use Utility Electric Power!

PETROLEUM ELECTRIC POWER ASSOCIATION

Box 1498, Oklahoma City, Oklahoma

pared from n-butyl bromide and magnesium. Decomposition of the Grignard is accomplished with water and ice yielding an ether layer that is washed, dried, and fractionated over sodium to produce 2-methyl-2-hexanol (92 percent yield).

(b) The alcohol is dehydrated by distillation in the presence of iodine, then washed, dried, and distilled over sodium to produce 2-methyl-hexene-2 plus a small amount of 2-methyl-hexene-1 (olefin yield 95 percent). This method is applicable to higher tertiary alcohols only.

(c) The olefins are hydrogenated by one pass over a nickel catalyst at 150°C., and the product washed, dried, refluxed with sodium, and then distilled. Yield of 2-methylhexane in this step is 82 percent.

Listed below are the 22 paraffins referred to above, the starting alcohol and intermediate olefin in each preparation, and literature references giving each preparation in more detail. It should be noted that the methods of dehydration and hydrogenation vary from one case to another.

2-methylpropane—Isobutyl alcohol to 2-methyl-propene-3 to paraffin[8].

n-butane—n-butanol to butenes to paraffin.[8]

2-methylbutane—Isoamyl alcohol to 2-methyl-butene-1 to paraffin.[45]

n-pentane—n-amyl alcohol to amylene to paraffin.[45]

2, 3-dimethylbutane—Pinacol to 2, 3-dimethyl-butadiene-1, 3 to paraffin.[11]

2-methylpentane—2-methyl-pentanol-2 to 2-methyl-pentene-2 to paraffin.[11]

3-methylpentane—3-methyl-pentanol-3 to 3-methyl-pentene-3 to paraffin.[11]

n-hexane—Ethyl-n-propyl carbinol to hexenes to paraffin.[11]

2, 2-dimethylpentane—2, 2-dimethylpentanol-3 to acetate to 2, 2-dimethylpentene-3 to paraffin.[45]

2-methylhexane—2-methyl-hexanol-2 to 2-methyl-hexene-2 to paraffin.[12]

3-methylhexane—3-methyl-hexanol-3 to 3-methyl-hexene-3 to paraffin.[12]

n-heptane—Heptanol-4 to heptene-3 to paraffin.[37]

2-methylheptane—6-methylheptanol-2 to 6-methyl-2-iodoheptane to paraffin.[9]

n-octane—Octanol-1 or octanal-2 to octenes to paraffin.[45]

2, 3-dimethylheptane—2, 3-dimethyl-heptanol-3 to 2, 3-dimethyl-heptene-3 to paraffin.[4]

2, 6-dimethylheptane—2, 6-dimethyl-heptanol-4 to 2, 6-dimethyl-heptene-4 to paraffin.[42]

4-methyloctane—4-methyl-octanol-4 to 4-methene-octane to paraffin.[10]

2-methyloctane—2-methyl-octanol-2 to 2-methyl-octene-2 to paraffin.[44]

4-methylnonane—4-methyl-nonanol-4 to 4-methyl-nonene-4 to paraffin.[5]

2-methylnonane—2-methyl-nonanol-3 to 2-methyl-nonene-3 to paraffin.[5].

3-methylnonane—3-methyl-nonanol-3 to 3-methyl-nonene-3 to paraffin.[5]

n-nonane—nonanol-2 to nonenes to paraffin.[45]

The other three hydrocarbons may have been prepared by essentially the same method outlined above, but, if so, data are not readily available.

3-methyloctane has been made by the Grignard synthesis, which is also applicable to many of the other hydrocarbons listed. The process for 3-methyloctane is as follows:[17]

The Grignard reagent is made by the action of 1-bromo-3-methyloctane on magnesium in anhydrous ether. This reagent is then hydrolyzed by water to yield 3-methyloctane.

n-decane and n-dodecane, as well as all other normal hydrocarbons from 5 to 12 carbons have been made by the Wurtz synethesis.[19] The reactants for n-decane were n-amylbromide and sodium. In general, the Wurtz reaction is not widely used, as yields are low and more drastic purification is necessary than with other methods.

A variety of special methods are available to synthesize individual hydrocarbons. Of these, probably the most important is the synthesis of n-heptane by the distillation of Jeffrey pine oil.

Commercial Manufacture of Paraffins

Only a few of the laboratory methods listed above are applicable to large-scale manufacture from a technical standpoint, and even these may fail because of economic considerations. The Grignard reaction, for example, is not adaptable because of inherent difficulties in handling large volumes of anhydrous ether. The alcohol-olefin-paraffin method, on the other hand, offers no such difficulties, provided the alcohol can be obtained from commercial sources. The dehydration and hydrogenation steps are practically always vapor-phase catalytic reactions of the types already employed on a large scale in the chemical industry. In certain cases, however, the starting alcohol may be obtained easily only through a Grignard reagent, and this step relegates the entire process to the laboratory. Alternate methods of synthesis of the alcohol would have to be devised to make the process practicable. To date, such overall economic processes have not been found. One of the reasons for this status is the fact that we do not yet realize the possibilities of the utilization of comparatively pure individual hydrocarbons.

In the last few years greater emphasis has been placed on the production of such materials, and as a consequence, refiners now produce in greater or lesser quantities the paraffins containing five or less carbon atoms, mixed hexanes, mixed heptanes, mixed octanes, and the well-known "neohexane" and "*iso*octane." Most of these hydrocarbons are produced by careful fractionation of petroleum distillates or natural gasoline. Further progress may be expected as the result of the azeotropic distillation method developed at the U. S. Bureau of Standards.[28]

When only limited amounts of a particular hydrocarbon are present in a given stock, they may sometimes be produced by subjecting certain fractions to cracking, reforming, alkylation, hydroforming, or similar reactions. Everyone is familiar with the alkylation process for making branched paraffins because of the widespread manufacture of "*iso*octane" (2, 2, 4-trimethylpentane) and neohexane. The materials in themselves are two reasons why it may pay engineers to follow research work being done on other pure hydrocarbons, and to study the methods by which they are synthesized in the laboratory.

Naphthenic Hydrocarbons

Twelve different naphthenic or alicyclic hydrocarbons have been isolated by Rossini and co-workers from the Mid-Continent petroleum previously mentioned.

The most suitable method for the preparation of the majority of these hydrocarbons in pure form is the catalytic hydrogenation of the corresponding aromatic hydrocarbon. This is carried out at room temperatures and slightly elevated pressures using a platinum-oxide plus platinum black catalyst, or at higher temperatures and pressures using a nickel catalyst.

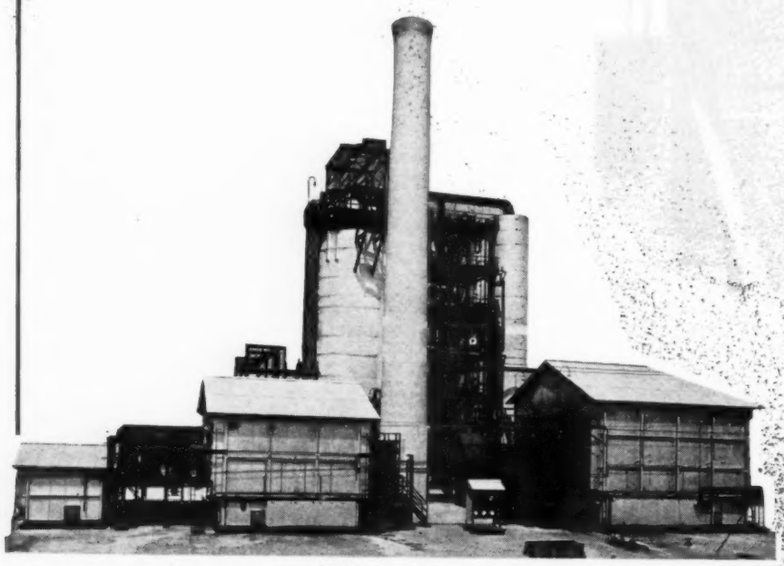
Examples of these two methods for the hydrogenation of benzene to cyclohexane are as follows:

1. 0.2 gm. platinum-oxide plus platinum black catalyst is kept in intimate contact with 15.6 gms. benzene in 50 cc. glacial acetic acid for two hours at 25-30°C. and under a hydrogen pressure of 2-3 atmospheres to yield cyclohexane almost quantitatively.[1]

2. A nickel catalyst (10 percent nickel, 90 percent Kieselguhr) prepared from nickel sulphate is kept in intimate contact with benzene in a 5-liter autoclave at 100-130°C. under a hydrogen pressure of 100 atmospheres until practically all benzene is converted to cyclohexane.[45]

(Continued on Page 102)

THE COMING *Petro-*



Petroleum and Chemical Engineers and Contractors Specializing

Chemical INDUSTRY

Engineering and Construction Service devoted to Chemical as well as Petroleum Refining Plants

MANUFACTURE of butadiene, toluol and alcohols from petroleum base sharply emphasizes the unlimited possibilities of the industry in the field of chemical production.

The long experience of the Badger Company in the design and construction of chemical as well as petroleum refining equipment and plants enables it, in a peculiarly fitting manner, to meet the requirements of the rapidly expanding Petro-Chemical Industry.

Licensing Agents for the Houdry Catalytic Cracking Process

E. B. BADGER & SONS CO.

Boston, Mass.

New York Philadelphia San Francisco London

Distillation, Evaporation, Extraction and Solvent Recovery

5-BCO-4

(Continued from Page 99)

Various naphthenic hydrocarbons that have been prepared by catalytic hydrogenation are listed below together with the raw material and the catalyst used.

Cyclopentane—From cyclopentadiene. Ni.[45]

Methylcyclopentane—From cyclohexane at high temperatures. Ni.[43]

Cyclohexane—From benzene. Ni.[45] Pt.[1]

Methylcyclohexane—From toluene. Ni.[45] Pt.[1]

1, 2-dimethylcyclohexane—From o-xylene. Pt.[32]

1, 3-dimethylcyclohexane—From m-xylene. Pt.[32]

Ethylcyclohexane—From ethylbenzene. Pt.[1]

1, 2, 4-trimethylcyclohexane—From pseudocumene (1, 2, 4-trimethylbenzene). Pt.[32]

The remaining four naphthenes have been prepared by the cycloalcohol-cycloölefin-cycloparaffin synthesis similar to the methods used for the production of paraffins from alcohols. These are:

1, 1-dimethylcyclopentane—1, 1-dimethyl-3-cyclopentanol to 1, 1 dimethylcyclopentenes to cycloparaffin.[7]

1, 3-dimethylcyclopentane—1, 3-dimethylcyclopentanol to 1, 3-dimethylcyclopentene to cycloparaffin.[6]

1, 2-dimethylcyclopentane—1, 2-dimethylcyclopentanol to 1, 2-dimethylcyclopentenes to cycloparaffin.[39]

1, 1-dimethycyclohexane—1, 1-dimethylcyclohexanol-3 to 1, 1-dimethylcyclohexenes to cycloparaffin.[7]

1, 2 and 1, 3-dimethylcyclohexanes, and ethylcyclohexane have been prepared in like manner.[30]

Commercial Manufacture of Naphthenes

The lower naphthene hydrocarbons listed (including the mono-substituted cyclanes) are already being produced commercially in varying amounts by the chemical industry. Within the last month one large chemical manufacturer has offered for sale moderate quantities of methylcyclohexane. Indications are that larger quantities could be manufactured if sufficient demand is forthcoming.

The production of these materials by catalytic hydrogenation of aromatics is readily adaptable to large-scale manufacture if pure raw materials are used. For those naphthenes that cannot be manufactured in this manner the cycloalcohol-cycloölefin-cycloparaffin method is available subject to the same limitations presented for the paraffins.

The production of the multi-substituted alicyclics may be possible industrially by isomerization of lower alicyclics and some aromatics by the action of aluminum chloride. For instance, upon heating in the presence of $AlCl_3$, isopropylcyclohexane yields 1, 3-dimethylcyclohexane,[25] and biphenyl yields 73.5 percent benzene, 18.5 percent methylcyclopentane, 4 percent toluene, and 4 percent cyclohexane.[46] In other cases, alkylation reactions may yield like materials, e.g., ethylene and cyclohexane in the presence of $AlCl_3$ produces a mixture containing about one-fourth 1, 3-dimethylcyclohexane.[15] Many other examples are presented in a recent monograph by Thomas.[36] The commercial success of such reactions will demand comparatively pure starting materials and careful fractionation of the resulting mixture. Impure starting materials usually yield such a complex mixture that simple methods of separation cannot be used.

Aromatic Hydrocarbons

The 21 aromatic hydrocarbons isolated by Rossini may be prepared by a wider variety of reactions than either the paraffins or naphthenes.

Benzene Hydrocarbons

The first two hydrocarbons in this series, benzene and toluene are obtained in pure form and in large quantities as by-products in the coking of coal. Greater demand than can be satisfied from this source has resulted in their manufacture from n-hexane and n-heptane, respectively. The same methods are suitable for their laboratory preparation.[13]

Probably the most widely used reaction for the synethesis of aromatic hydrocarbons is the Friedel and Crafts reaction by means of which an alkyl halide condenses with a benzene compound in the presence of $AlCl_3$. Other closely related reactions used for the preparation of alkyl benzenes are the reaction of benzene with alcohols, esters, ethers, olefins, and naphthenes in the presence of condensing agents such as BF_3, H_2F_2, and H_2SO_4. The choice of the particular combination to use in a given case is a difficult problem except in the light of experience. Both rearrangement and the point of entry of an alkyl group into the ring may vary with the conditions used.

An excellent example of such variation has been presented by Ipatieff, Pines, and Schmarling.[16] They have shown that the condensation of n-propyl alcohol with benzene in the presence of sulphuric acid yields *iso*propylbenzene, whereas the same reactants in the presence of $AlCl_3$ yield n-propylbenzene. A critical survey of these condensation reactions, which presents many details and techniques, is available in the recent monograph by Thomas on "Anhydrous Aluminum Chloride in Organic Chemistry."[36]

The specific methods listed below will be found satisfactory for the particular hydrocarbons mentioned.

Toluene—Benzene, CH_3Cl, $AlCl_3$.[43]

Ethylbenzene—Benzene, ethylene, $AlCl_3$;[22] benzene, ethyl acetate, $AlCl_3$.[4]

m-xylene—Toluene, CH_3Cl, $AlCl_3$.[24]

*Iso*propylbenzene (cumene) — Benzene, propylene, H_2F_2;[31] benzene, n-propylalcohol, H_2SO_4.[16]

1, 3, 5-trimethylbenzene (mesitylene)—Benzene, CH_3OH, $AlCl_3$.[23,24]

1, 2, 4-trimethylbenzene (pseudocumene)—Benzene, CH_3Cl, $AlCl_3$.[24]

n-propylbenzene—Benzene, n-propylformate, $AlCl_3$;[4] benzene, n-propyl alcohol, $AlCl_3$.[16]

m-ethyltoluene—Benzene, ethanol, $AlCl_3$.[38]

p-ethyltoluene—Toluene, ethylidene chloride, $AlCl_3$.[2]

The five other benzene hydrocarbons are more satisfactorily made by the types of reactions shown below.

o-xylene—o-bromotoluene, methyl iodide, and sodium.[43]

p-xylene—p-bromotoluene, methyl iodide, and sodium.[43]

1, 2, 3-trimethylbenzene (hemimellitine)—Benzyl chloride to o-methyl benzyl alcohol (70 percent yield) to o-methyl benzyl chloride (91 percent) to 2, 3-dimethyl benzyl alcohol (45 percent) to hemimellitine (92 percent).[35]

o-ethyltoluene—Clemmensen reduction of o-methylacetophenone.[41]

1, 2, 3, 4-tetramethylbenzene (prehnitene)—Jacobsen reaction in which durene sulfonic acid or related compounds are treated with cold H_2SO_4 and then hydrolyzed to give good yields of prehnitene.[33,34]

Alternate methods for two of the hydrocarbons mentioned above are widely used, and are listed below.

Mesitylene is commonly made by the condensation of acetone,[14] and pseudocumene may be made in 40 percent yields by the Grignard reaction in which magnesium, bromo-m-xylene, and methyl iodide are reacted in the presence of anhydrous ether.[20]

Naphthalene Hydrocarbons

1, 2, 3, 4-tetrahydronaphthalene (tetralin)—Hydrogenation of napthalene over Raney nickel or copper-chromium oxide (nearly quantitative).[21]

Naphthalene—Available in large quantities from coal tar.

6-methyltetralin—Tetralin, CH_3Cl, $AlCl_3$.[3]

5-methyltetralin—Grignard reaction between brominated tetralin, magnesium, and methyl sulphate in anhydrous ether results in a mixture of 5- and 6-methyltetralin.[40]

2-methylnaphthalene — 2-aldonaphthalene is made by 4-step synthesis

(Continued on Page 105)

(Continued from Page 102)

from naphthalene and subjected to Clemmensen reduction. Overall yield from naphthalene—14 percent.[29]

1-methylnaphthalene — 1-bromonaphthalene, methyl iodide, and sodium (Wurtz-Fittig reaction).[43]

Aromatic Hydrocarbons

For a number of years, aromatic hydrocarbons with short side chains such as benzene, toluene, xylenes, naphthalene, and methylnaphthalenes have been produced as by-products of the coking of coal. With the exception of toluene, adequate quantities of these hydrocarbons are still produced in this manner. The manufacture of toluene by the cyclization of heptane has been described in various articles,[13] and the same type of process is suitable for the manufacture of the other benzene hydrocarbons on a commercial scale.

The other type of process that might be suitable for commercial purposes is the condensation reaction using $AlCl_3$, H_2SO_4, BF_3, and such materials as condensation reagents. In such cases, however, the separation of pure products would still present many technical difficulties.

References

1. Adams and Marshall, J. Am. Chem. Soc. *50*, 1970-3 (1928).
2. Anschutz and Romig, Ber. *18*, 662-6 (1885).
3. Barbot, Bull. Soc. chim. [4], *47*, 1314-23 (1930); Chem. Abs. *25*, 943 (1931).
4. Bowden, J. Am. Chem. Soc. *60*, 645-7 (1938).
5. Calingaert and Soroos, J. Am. Chem. Soc. *58*, 635-6 (1936).
6. Chavanne, Bull. sci. acad. roy. Belg. [5], *12*, 105-22 (1926); Chem. Abs. *20*, 2664 (1926).
7. Chavanne, Miller, and Cornet, Bull. soc. chim. Belg. *40*, 673-88 (1931); Chem. Abs. *26*, 2712 (1932).
8. Coffin and Maass, J. Am. Chem. Soc. *50*, 1427-37 (1928).
9. Clarke, J. Am. Chem. Soc. *31*, 107-16 (1909).
10. Clarke, J. Am. Chem. Soc. *34*, 680-3 1912).
11. Cramer and Mulligan, J. Am. Chem. Soc. *58*, 373-4 (1936).
12. Edgar, Calingaert, and Marker, J. Am. Chem. Soc. *51*, 1483-91 (1929).
13. Grosse, Morrell, and Mattox, Ind. Eng. Chem. *32*, 528-31 (1940).
14. Ipatieff, Dolgov, and Volnov, Ber. *63B*, 3072-8 (1930).
15. Ipatieff, Komarewsky, and Grosse, J. Am. Chem. Soc. *57*, 1722-4 (1935).
16. Ipatieff, Pines, and Schmerling, J. Org. Chem. *5*, 253-63 (1940).
17. Levene and Marker, J. Biol. Chem. *91*, 77-103 (1931).
18. Maass and Wright, J. Am. Chem. Soc. *43*, 1098-1111 (1921).
19. Mair, Bur. Standards J. Research, *9*, 457-72 (1932).
20. Maxwell and Adams, J. Am. Chem. Soc. *52*, 2959-72 (1930).
21. Musser and Adkins, J. Am. Chem. Soc. *60*, 664-9 (1938).
22. Natleson, Ind. Eng. Chem. *25*, 1391-5 (1933).
23. Norris and Ingraham, J. Am. Chem. Soc. *60*, 1421-3 (1938).
24. Norris and Rubenstein, J. Am. Chem. Soc. *61*, 1163-70 (1939).
25. Pines and Ipatieff, J. Am. Chem. Soc. *61*, 1076-7 (1939).
26. "A Decade of Research on the Chemical Constitution of Petroleum," by Frederick D. Rossini. Paper presented at A.P.I. Annual Meeting, Chicago, Illinois, November, 1937.
27. "Progress Report on the Hydrocarbons in the Kerosine Fraction of Petroleum, A.P.I. Research Project 6," by Frederick D. Rossini and Beveridge J. Mairn. Paper presented by J. Bennett Hill, Sun Oil Company, before A.P.I. Annual Meeting, San Francisco, California, November, 1941.
28. "Use of Azeotropic Distillation in Separating Hydrocarbons from Petroleum," by Frederick D. Rossini, Beveridge J. Mairn. and Augustus R. Glasgow, Jr. Paper presented before Division of Refining, A.P.I. Annual Meeting, Chicago, Illinois, November, 1940.
29. Sah, Rec. trav. chim. *59*, 461-70 (1940); Chem. Abs. *35*, 4763 (1941).
30. Signaigo and Cramer, J. Am. Chem. Soc. *55*, 3326-32 (1933).
31. Simons and Archer, J. Am. Chem. Soc. *60*, 2952-3 (1938).
32. Skita and Schneck, Ber. *55B*, 144-52 (1922).
33. Smith and Cass, J. Am. Chem. Soc. *54*, 1614-21 (1932).
34. Smith and Lux, J. Am. Chem. Soc. *51*, 2994-3000 (1929).
35. Smith and Spillane, J. Am. Chem. Soc. *62*, 2639-43 (1940).
36. Thomas, "Anhydrous Aluminum Chloride in Organic Chemistry," Reinhold, 1941.
37. Tishchenko, Belopol'ski, Ignatovitch, and Likhacher, J. Appl. Chem. (U. S. S. R.) *11*, 639-42 (1938); Chem. Abs. *32*, 7013 (1938).
38. Tsukervanik and Vikhrova, J. Gen. Chem. (U. S. S. R.) *7*, 632-6 (1937); Chem. Abs. *31*, 5779 (1937).
39. Van Rysselberge, Bull. sci. acad. roy. Belg. [5], *11*, 171-92 (1926); Chem. Abs. *21*, 375 (1927).
40. Vesely and Stursa, Chim. Listy. *29*, 361-3 (1935); Chem. Abs. *30*, 8202 (1936).
41. von Auwers, Ann. *419*, 92-120 (1919); Chem. Abs. *14*, 927 (1920).
42. White, Rose, Calingaert, and Soroos, J. Res. Natl. Bur. of Stds. *22*, 315-19 (1939).
43. Whitmore, "Organic Chemistry," D. Van Nostrand, 1937.
44. Whitmore and Southgate, J. Am. Chem. Soc. *60*, 2571-3 (1938).
45. Wibaut, Hoog. Langedijk, Overhoff, and Smittenberg, Rec. trav. chim. *58*, 329-77 (1939).
46. Yur'ev and Levina, Sci. Repts. Moscow State Univ. *3*, 203-7 (1934); Chem. Abs. *30*, 8192 (1936).

☆☆☆

P 094.83

Maintaining Explosion-Proof Electrical Equipment

by Phelan McShane

Westinghouse Electric and Manufacturing Company

MANY instructions have been compiled on the proper maintenance for explosion-resisting apparatus in order to insure safe operating conditions. Fortunately, however, there are certain fundamental rules that cover the important instructions and at the same time can be easily understood and remembered. Equipment should be clean, parts kept tight that should be tight, and free moving parts kept free.

Aside from keeping the equipment clean, the maintenance schedule to be followed in the case of explosion-resisting apparatus is exactly that which should be followed in connection with non-explosionproof apparatus. The motors should be thoroughly blown out at regular intervals, the commutators kept in good condition, and the brushes free in the holders.

The control apparatus should be kept clean by an occasional wiping of all insulated surfaces between live parts. The contactors and relays should be maintained in first-class condition.

Although explosion-resisting apparatus is thoroughly enclosed, it cannot be hermetically sealed, and due to heating and cooling, air is drawn in and expelled from the enclosure. The air entering the controllers despite anything that can be done carries with it coal and other dust. In many instances the dust is conducting, particularly when moist, and for this reason all surfaces within the controllers across which electric leakage is likely to occur should be kept scrupulously clean.

It is realized that it is inconvenient to open up controllers and motors to thoroughly clean the equipment, but it is very much less trouble to do this occasionally than it is to perform major repairs that will certainly follow neglect.

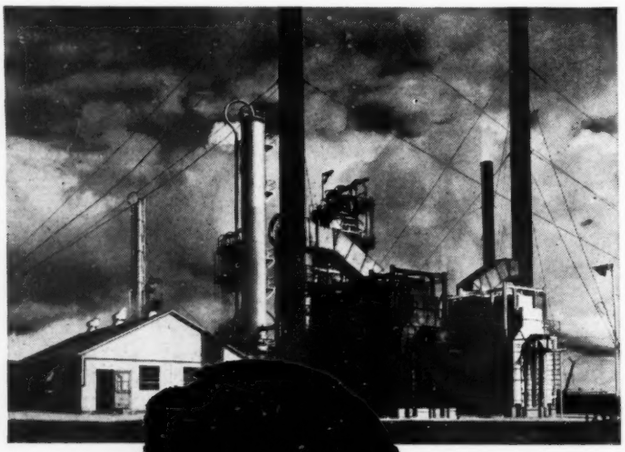
Of interest to both the manufacturers and to those making use of the equipment is a publication of the U. S. Bureau of Mines containing the requirements for explosion-resisting apparatus and indicating the proper maintenance practices.

We're Old Hands!

BRADEN STEEL CORPORATION TULSA OKLA

when it comes to taking care of Refinery Housing Requirements.

Here's a typical low cost refinery building supplied from our stock of Standardized Sectional Steel Buildings. Width 34', Length 60', Height 10'.



Any refinery housing requirement can be met, for style and size, with a Braden Standardized Sectional Steel Building.

Eighteen years of experience in designing, fabricating and erecting "Weather-Proof" Sectional Steel Buildings for the refining industry has established the reputation "It's true economy to buy Braden Buildings."

Braden's Engineering Department will submit sketches, plans and estimates without cost. Write—

BRADEN STEEL CORPORATION

1007 EAST ADMIRAL BLVD. TULSA, OKLA.

Gulf Coast Branch Office:

R. W. (Bob) Rogers, 1314 Esperson Bldg., Houston. Tel. Charter 4-5918

Representatives:

E. L. Hagar, 1815 S. Baltimore Ave., Kansas City, Mo. Tel. Victor 2618

H. E. Boggs, 1101-05 Grant St., Amarillo, Tex. Tel. 2-5262

BRADEN STEEL

Reclaiming Used Refinery Equipment

PETROLEUM ENGINEER Exclusive Feature

☆ **Some of the ways in which salvage programs and improved cleaning techniques can help the refiner make his equipment give longer service, increase operating efficiency, and reduce maintenance cost**

by Arthur P. Schulze

Oakite Products, Inc.

IN building new refining capacity and enlarging present facilities needed to expand output of 100-octane aviation gasoline, motor fuel, residual fuel oil, and extreme-service lubes and greases required by the Nation's armed forces and those industries fabricating essential war supply items, as well as to increase production of hydrocarbons for synthetic rubber, the petroleum industry is being given special consideration regarding steel and other critical metals and materials. Nevertheless, new equipment to replace obsolete units will undoubtedly become increasingly difficult to obtain. In addition, from current indications, shortages of repair and replacement parts and supplies are becoming a problem that concerns practically all branches of the refining and producing industry. It means that ways must be found and measures taken to make refining equipment in current use last longer.

It is for these reasons that reconditioning and salvaging of existing or discarded equipment today is a project to which all concerns in the petroleum industry are giving greatly increased attention. In more and more plants from the Atlantic Seaboard to the Pacific Coast, intensive reconditioning and reclamation programs are being introduced. Refinery personnel, especially maintenance men, machinists and pipe fitters, are becoming increasingly conscious of the vital necessity for conserving old, used machinery, equipment, and other materials either for possible re-use or for conversion into scrap that can be used for war manufacturing purposes.

This article therefore discusses, in a general way, certain types of reclamation and maintenance work and the use of improved cleaning techniques for handling related operations, all based on successful experience of a number of companies that have already established their maintenance and reclamation procedures on an efficient operating basis. The actual economies effected and other advantages gained, particularly in regard to maintenance of existing equipment, have contributed materially not only to reducing the need and frequency of parts replacement, but also in increasing the useful operating life of the equipment itself.

ARTHUR P. SCHULZE

is connected with Oakite Products, Inc., New York, New York, and is a graduate of the University of Missouri, Columbia, Missouri.

In connection with the conservation of present equipment and reclamation of used units, it should be mentioned that the steady progress made during the last decade in "preventive maintenance" and "saving by salvage" has been made possible to a great degree by the extensive chemical research and mechanical engineering work, both in the laboratory and in the field, conducted by manufacturers of commercial cleaning compounds and related supplies.

Planned search for new or improved ways of doing old jobs better has brought about the development of specialized materials and techniques that can be readily adapted to handling almost every type of equipment maintenance or reclamation work on a fast, effective, low-cost basis.

To illustrate, consider briefly a few of the more important types of work where reclamation or maintenance can effectively aid in making equipment last longer and function more efficiently—two objectives that war-time production schedules and the necessity for continuous refinery operation are making absolutely imperative.

Salvaging Valves, Fittings, Etc.

For salvage degreasing or cleaning of non-machinery items—piping, pipe hangers, fittings, gears, flange-type connections, elbows, nipples, and similar parts—a combination of several factors must often be considered before determining the greater efficiency of one particular method or material over another. Among them are the type and amount of deposits to be removed, equipment needed, and heating facilities available.

When special conditions make one factor more important than others, it usually proves profitable before the actual work of salvage is begun to solicit the ideas and suggestions of a cleaning materials manufacturer who is thoroughly experienced and conversant with this type of work. Any oil refinery or natural gasoline plant contemplating doing this work will thus have direct, first-hand assurance from the outset that the work is put on a practical basis in accordance with soundly engineered cleaning principles.

Tank-Cleaning of Small Parts

For average requirements, tank degreasing or cleaning is usually the simplest and most feasible method of handling small parts. Equipment required consists of a tank of sufficient size and capacity to hold the largest parts to be cleaned, and which is equipped with steam coils or other suitable heating medium to supply the necessary heat; a chain hoist to facilitate handling of parts or works, and means for agitating the cleaning solution.

The tank is charged with a solution of a suitable heavy-duty alkaline degreasing or cleaning material designed

to remove carbonized oil, encrusted grease, sludge, and muck deposits. With the choice of the correct material comes the question of the concentration at which it should be employed to obtain the quickest and most economical results.

Within a given range, most degreasing work is accelerated by the use of higher concentrations of material although occasionally, paradoxical though it may seem, weaker solutions may be more effective than stronger ones, when maintained at correct operating temperatures. For average salvage work, concentration generally ranges from 4 to 8 oz. per gal. of water. After the solution is brought to a temperature varying from 180° to 212°F., parts are immersed in the tank for varying periods of time, this depending upon the amount and type of deposits to be removed and the speed of cleaning desired. Heavy accumulations are either completely removed or are so thoroughly softened and loosened that they can be easily "knocked off" with a pressure-hose rinse. Parts or work are then ready for inspection and any necessary repairs, or for immediate repainting and restocking for further use.

Photo shows valve used in acid sludge service. Right half has been cleaned indicating effectiveness of cleaning operation in salvage work

Cleaning Tank Installation

There are several important points to bear in mind when planning a tank installation for handling work with hot degreasing solutions. Certain fundamental mechanical features should be incorporated in most installations if maximum results are to be obtained at minimum cost.

The first consideration, of course, is the tank itself. Obviously, it should be preferably of welded steel construction and of a size to take a sufficient volume of work to permit thorough degreasing in the time that can be given to the operation.

Next comes heating. Steam is usually readily available, and because of this and its adaptability to the work, it has become the most common medium for heating degreasing tanks.

To prevent waste of the muck-removing solution through condensation and dilution, closed steam coils should be used. Equally important from the standpoint of results and economy, is the desirability of placing the coils along that side of the tank in which the work is immersed and withdrawn. The reason for this is that if the steam coils are placed on the bottom of the tank, they will become covered with heavy muck deposits that impair heating efficiency. In this position coils are also susceptible to damage if heavy work is dropped upon them.

Thermosyphon Cleaning Action

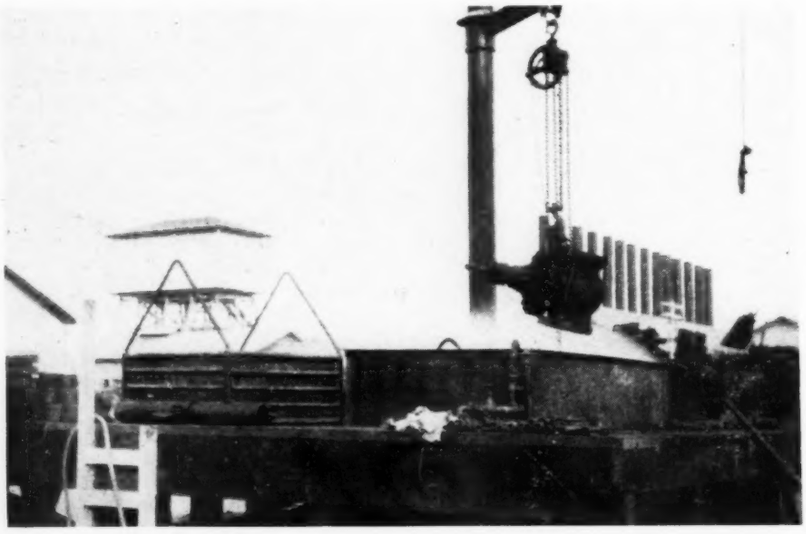
A third important factor in making a suitable degreasing tank installation is that of agitation. It has been found that any device that increases the "roll" or agitation of the solution will either speed-up or improve the detergent action of the material used. Air is objectionable because it causes foaming and also cools the solution. Many plants have discovered that excellent agitation may be obtained by the use of a simple device known as an "agitation shield." Consisting of an iron plate suspended over the heating coils, its purpose is to establish a thermosyphon action.

The shield has a water-tight joint at the top and extends to within 6 in. of the bottom of the tank. Perforated holes in the shield permit the emission of the solution. When the steam is turned on, cool solution enters the space between the shield and the tank side, at the bottom. It is then heated by the coils and, as it becomes hotter, it rises with sufficient "lift" to cause it to be discharged through the perforation in the shield and set up a violent agitation.

The continuous action or mechanical effect of this roll or agitation of the solution is an effective aid to efficient grease and oil removal, and for this reason the installation of a shield is most advisable whenever there is ample clearance between the work baskets and the tank sides.

With suitable heating coils in the tank, provision should also be made for maintaining the degreasing solution at its most efficient operating temperature. To control this, a proper thermometer or heat-recording device is recommended. It should be placed on the coolest side of the tank and should record the temperature about two-thirds of the way below the top of the solution. A dial thermometer, which may be read at a short distance, should be installed, as it enables the tank oper-

Here is simple degreasing and cleaning tank installation that meets requirements of one company in preparing dismantled equipment for repair and reconditioning. Chain hoist facilitates handling of large parts, and reinforced wire basket shown in left foreground provides easy handling of small parts



ator to maintain correct temperatures of solutions at all times.

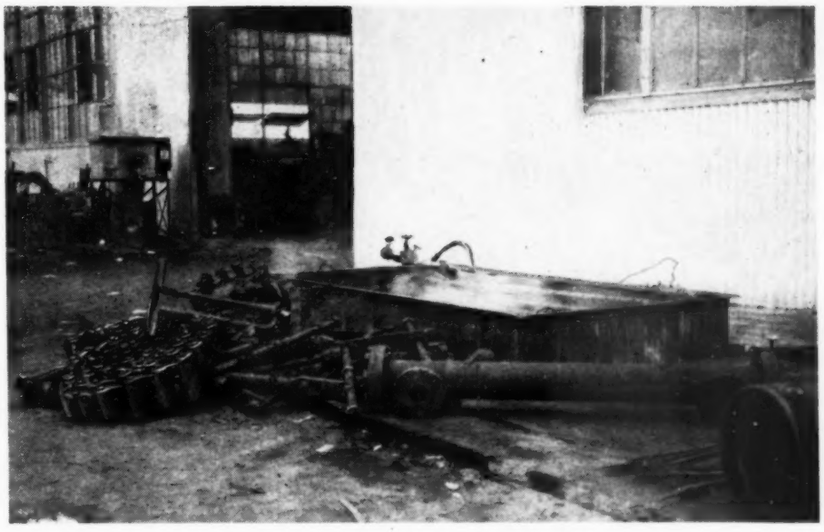
There are, of course, various other factors to be considered in making a tank installation but which, due to lack of space, cannot be discussed fully here. But the main points covered should serve as a helpful guide to any concern now planning a new tank installation or one that desires to improve the efficiency and economy of its existing tank equipment.

Steam-Detergent Method

Although immersion of the work in a tank is one of the most widely used methods of degreasing parts before repair, reconditioning, or repainting, frequently it is not suitable for large, heavy equipment such as trucks, tractors, engines, and pumps. There is, however, an alternate method for effectively handling this work that provides results equal in every respect to tank-cleaning. That method is steam-detergent degreasing, or the projection of a high-velocity spray of steam and a suitable grease-removing solution through a steam gun of the proper type and design, bringing to the surfaces to be cleaned the triple, scientifically balanced combination of heat, mechanical force correctly applied, and effective detergent action to loosen and remove even heavy, caked-on oil, grease, and dirt deposits.

The use of steam-detergent cleaning in connection with regular equipment maintenance or periodical repair and overhaul work is not an entirely new practice to the petroleum industry. Throughout the last 10 or 15 years, steam-detergent cleaning has steadily progressed for a number of reasons. First, it is a natural time and effort-saver because it eliminates tedious, time-consuming scraping, and costly hand-scrubbing methods. Second, by enabling equipment of almost any size and shape to be degreased quickly and inexpensively, this method provides for more effective results on an almost endless variety of work than are practicable in any other way. Also, by displacing the use of flammable solvents formerly employed in many instances to soften oil and grease accumulations before manual scraping and scrubbing operations, it assures greater safety to plant, personnel, and equipment.

From the standpoint of results, there are practically no limitations on steam-detergent cleaning and although widely and successfully used at the present time, the method has not previously enjoyed the most extensive use possible due largely to the initial high cost of installing the method and lack of portability of the equipment previously required with it. Until recently, it was necessary to have not only a steam supply of 30-lb. pressure or more, but also auxiliary apparatus such as pumps, motors, injectors, or a pressure solution supply tank to lift the cleaning solution to the level at which the work was being done. Any of these meant added installation expense.



Another typical tank installation for salvaging chains, sprockets, gears, pipe fittings, connections, and similar equipment. A short soak in a steam-heated tank charged with proper alkaline degreasing solution, followed by a pressure-rinse, removes deposits and leaves parts in clean, muck-free condition

Another common practice was to utilize a gravity flow from an overhead tank placing a 50-gal. solution drum on a platform at a point higher than any of the surfaces to be reached by the steam gun. The main disadvantage of this particular system is that it is not portable, so that work has to be brought to it. In this case, too, cost of installation frequently is comparatively high.

Simplified Equipment

Through certain innovations and improvements made during the last few years in the design and operating effectiveness of the equipment required for the steam-detergent method of cleaning, the cost and portability problems previously experienced have been successfully solved.

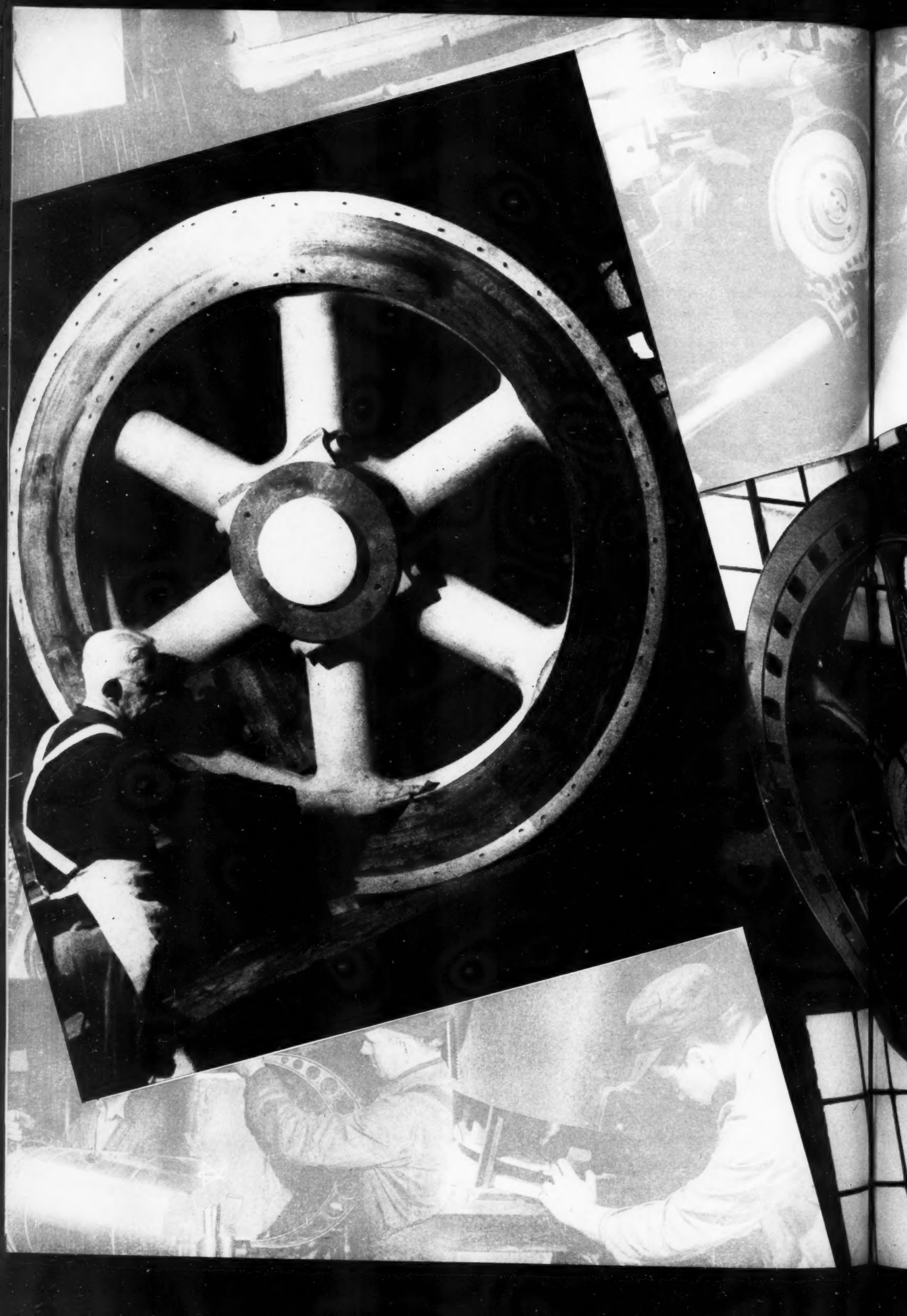
One advancement of major importance in this direction has been the recent development of a highly improved type of steam-detergent gun (patent applied for) that now enables practically any plant to make a simple yet effective installation at a fraction of the cost usually required heretofore.

Beyond its light weight and ease of use, the basic improvement provided by this new type of steam-detergent gun is its unusual, exclusive, "solution-lifting" feature that accounts for its ability to lift automatically the cleaning solution from a metal drum or container resting on the ground or other conveniently low level to a working height of 12 ft. without the aid of the accessory apparatus previously required for steam-detergent cleaning. All that is necessary to operate such a unit is a steam supply of 30-lb. pressure or more, hoses for steam and cleaning solution, and a metal drum or tank that, if mounted on a truck or cart, may be readily moved about the plant direct to the work itself. No motors, pumps, etc., are required. Thus, the equipment may be used wherever a steam line is within reach of a steam outlet. In many oil refineries and natural gasoline plants, adequate steam pressure is readily available so that the cost of this simple but highly effective steam-detergent unit amounts to a very nominal figure compared with the saving in time, money, and manual effort resulting from use in connection with equipment maintenance, repair, and overhaul work.

Heat Exchange Equipment

The need of cleaning pre-heaters, steam generators, condensers, coolers, interchangers, reboilers, dephlegmators, and other types of heat exchangers at regular intervals to maintain thermal capacity and heat transfer efficiency at the high point that economical refinery operation requires, has long been recognized. But because it has been found time and again that certain cleaning procedures have a definite re-

(Continued on Page 112)

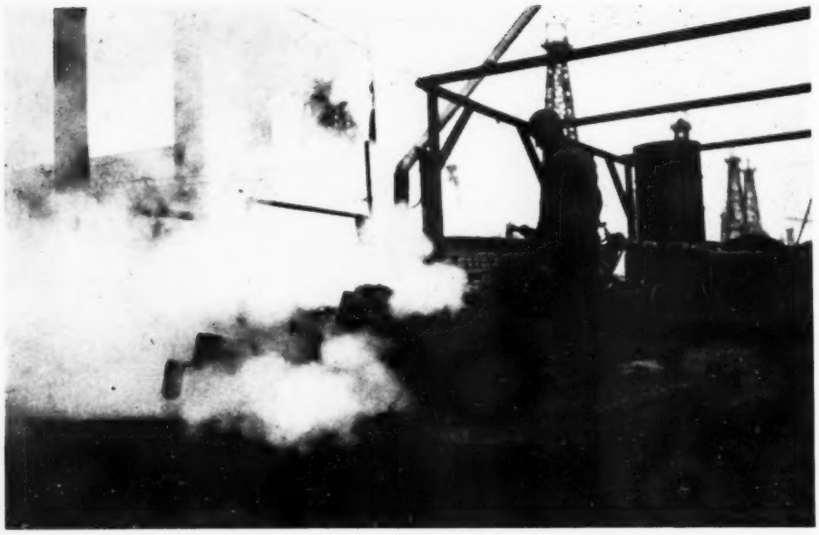


CLARK MEN

and the will to win!

They are working as an army, the men of Clark Bros. — as well organized, self-sacrificing and determined an army as has ever engaged in war . . . They know the critical importance of their product — the vital part that Clark Compressors play in speeding the production of high-octane gasoline; in manufacture of synthetic ammonia gas, hydrogen and nitrogen used in the making of explosives; in serving as "boosters" on natural gas transmission lines serving war production plants . . . Because they want peace, they are working 24 hours a day to provide the implements of war . . . This message is our tribute to their loyalty!

CLARK



By combining the powerful physical action of steam with the effective detergent properties of a suitable cleaning material, steam-detergent method provides a fast, easy method of cleaning large equipment such as pump and engine parts, tractors, trucks, etc.

(Continued from Page 109)

lationship to tube failures and the necessity and frequency of replacement, maintenance of heat exchangers is a subject without which no review of ways to obtain longer service from equipment would be complete.

So it is from these standpoints primarily that the various methods and materials generally employed for removing both oil residues and lime-scale deposits will be briefly outlined.

Impracticable Methods

One of the most common methods of removing carbonized oil and sludge deposits from shell-and-tube type heat exchangers has been that of drilling or rodding-out the tubes by mechanical means. As many refinery maintenance men know, this is a tedious manual operation that usually requires dismantling of units. Moreover, it is often far from being the most practicable procedure for solving the problem. With modern heat exchanger design involving the use of numerous small tubes, which are mainly ⅝ in., ¾ in., and 1 in. O. D. and of various lengths to meet specific operating conditions, the walls of these tubes are usually thin. Thus, when tubes are cleaned mechanically, there is danger of damaging them. This is due to the fact that the residue to be removed frequently settles in the bottom of the tube and may offer more resistance to the rodding tool than the top, so that the tool is projected against either side of the tube, cutting or abrading portions of it and reducing wall thickness, which in turn may lead to failure.

Another technique employed, particularly for removing soft and loose deposits such as certain types of sludges and the softer type oil residues, is that of blowing steam or hot water through the exchanger. Still another practice, which has become more common in recent years, is the forcing of plastic plugs through the tubes either by means of steam pressure, water pressure, or compressed air. This, too, experience has shown, is usually suitable only in those cases where soft sludge-like deposits are encountered.

Circulation Method

Because of these and other disadvantages, considerable research has been devoted to the problem of removing carbonized oil and sludge deposits from heat exchange equipment by chemical compounds that could be more easily and effectively utilized and applied than mechanical methods. As a result, the last decade has witnessed the development of various specialized alkaline and solvent type cleaning materials having the ability to loosen and remove heavy accumulations of insulating foreign deposits from the oil side of heat exchanger tubes without adversely affecting equipment.

Of equal importance is the additional fact that the need and demand for a practical yet relatively simple and economical procedure to apply solutions of these cleaning compounds also have been met satisfactoriy. Known as the "circulation method", it is exactly what the name implies: a method whereby the sludge-removing solution is circulated through the oil side of fouled units for a certain period of time, followed by thoroughly flushing-out the system with water. The time required to do the job, obviously, is largely governed by the fouled condition of the unit and the interval that has elapsed since the unit was previously treated. Size of the unit is another factor.

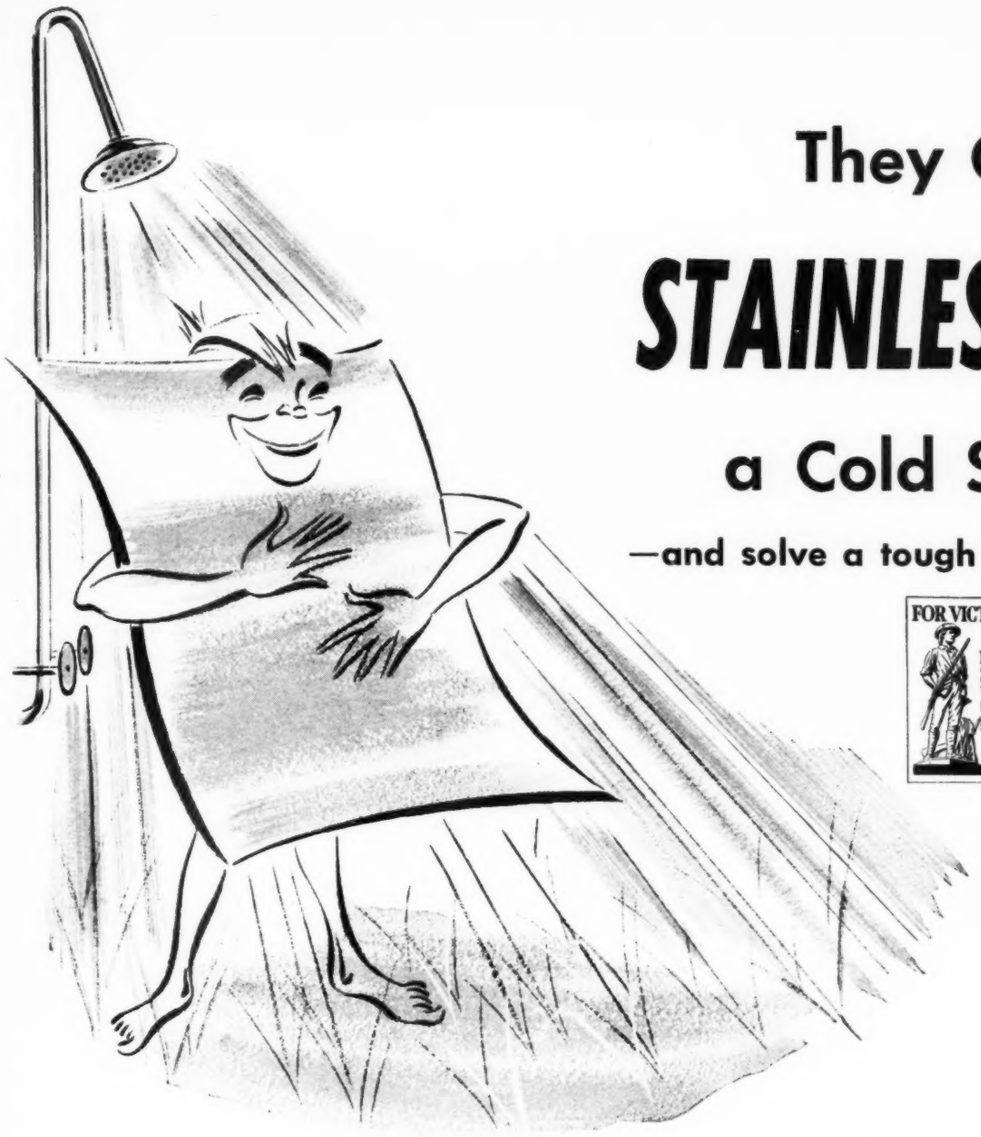
The equipment required for using this successful and improved method consists essentially of a large and adequate pump, an open solution tank for mixing the cleaning material, piping connections and valves, a steam connection for heating the solution, and steam or air connections to agitate the cleaning solution at intervals as it flows through the heat exchange unit.

In dislodging and removing heavy deposits, this circulating method provides many worthwhile features from the standpoints of efficiency and time-saving. The first is the principle of "reverse flow". It has been found in many cases that faster and more effective cleaning results may be obtained when the directional flow of the solution is changed during the cleaning operation. For example, there are cases where reversing the flow of direction every 30 minutes over an eight-hour period has removed deposits that stubbornly resisted a much longer flow in one direction only. For this reason it generally proves economical to add the fittings and valves needed to effect reversal of flow.

Providing connections for steam or air injection also has frequently proved a great aid in disintegrating and removing deposits that resist other treatment. Finally, the use of a settling drum before the cleaning solution returns to the tank is also an element to be considered, for if the deposits are of such a nature that a considerable amount of insoluble matter is carried in the cleaning solution, it is preferable to trap the insoluble carbon particles and sludge in a settling drum rather than allow them to be picked-up by the pump and re-circulated into the heat exchangers.

Advantages

Wherever applicable, this method provides several distinct advantages when compared to mechanical cleaning. Either one side or both sides of the tube bundle are cleaned simultaneously by this method. On the other hand, mechanical methods are not readily adaptable for removing encrusted deposits on exterior surfaces of tubes. Obviously, there is far less manual effort involved in hooking up the



They Give

STAINLESS STEEL

a Cold Shower

—and solve a tough corrosion problem

IN equipment for handling dilute sulfuric acid, tests under operating conditions indicated that 18-8 Stainless Steel containing molybdenum would give satisfactory service life under the highly corrosive conditions. The corrosion resistance and high strength of this material permitted engineers to use a new and more efficient design. When plant operations began, it was found that even this highly-resistant steel was being corroded in a few spots. Electro Metallurgical Company engineers were asked to solve the problem.

Inspection showed that due to increased temperature of certain parts of the equipment above the liquid level the dilute acid was being concentrated. This concentrated acid combined with higher temperatures produced the corrosion. The solution to the problem was a water spray on the affected areas to prevent temperature rise and subsequent acid concentration.

In stainless steel equipment handling dilute acids or acidic vapors, it is important that acids are not allowed to concentrate where they may cause corrosion. Periodic inspection of your stainless steel equipment, especially stacks and flues, will show whether you have such a corrosion problem in your plant.

Although we do not make steel, we have for more than 35 years produced "Electromet" ferro-alloys used in the making of steel. With the knowledge accumulated from this experience we are in a position to give impartial advice on the selection and use of stainless steels. If you have a specific problem in the use, maintenance, or fabrication of stainless steel, consult us.

ELECTRO METALLURGICAL COMPANY

Unit of Union Carbide and Carbon Corporation

30 East 42nd Street UCC New York, N. Y.

In Canada: Electro Metallurgical Company of Canada, Limited, Welland, Ontario

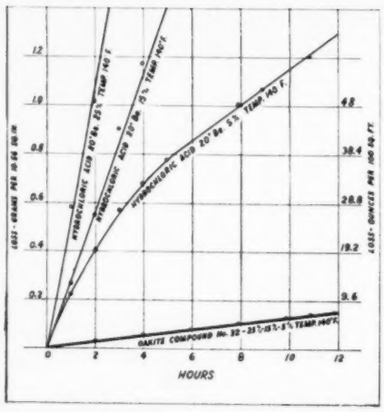
Electromet

Trade-Mark

Ferro-Alloys & Metals

pump tank and piping connections than is required in removing the head of the exchanger, erecting a scaffold for cleaning, or employing other means of conveying the bundle from the shell, particularly on large units.

This modern chemical cleaning method is also superior from three other important standpoints. First, circulation of the cleaning solution does not damage the equipment. Second, down-time for cleaning is considerably shorter so that units are returned to service in less time than otherwise would be possible. In fact, much of the work required may be done before the shut-down actually begins. With the circulation method heat exchangers need be opened only for periodical inspection or in case of some mechanical failure that may require replacement of parts. Even these stoppages may be substantially reduced, however, by adopting and following a regular schedule of cleaning frequent enough to prevent the equipment from becoming badly fouled. When such a plan is followed, interruption to service is kept at a minimum and equipment is maintained in better operating condition. Third, as the circulating method eliminates the need of dismantling units and avoids the time and manual effort mechanical cleaning generally entails, it is more economical.



This graph illustrates the negligible loss of metal resulting from use of specially developed, inhibited acidic materials on iron and steel in lime-scale removal, as compared with loss that occurs when raw acid solutions of various concentrations are used

Lime-Scale Removal

Until a comparatively short time ago, the removal of lime-scale deposits from various types of heat exchange units in general has been a difficult job. Here again the practice of drilling or rodding-out tubes has been quite common. But because of the time and cost factors, as well as the possibility of damaging tubes involved with this method, muriatic acid solutions have been frequently utilized as an alternate means of de-scaling. This practice is not always satisfactory, because experience indicates that whereas muriatic acid removes lime-scale deposits, it also readily attacks or "eats" into surfaces of certain metals. If used repeatedly, muriatic acid reduces tube wall surfaces to a point where they may be easily punctured unless extreme care and control are constantly exercised in applying such de-scaling solutions.

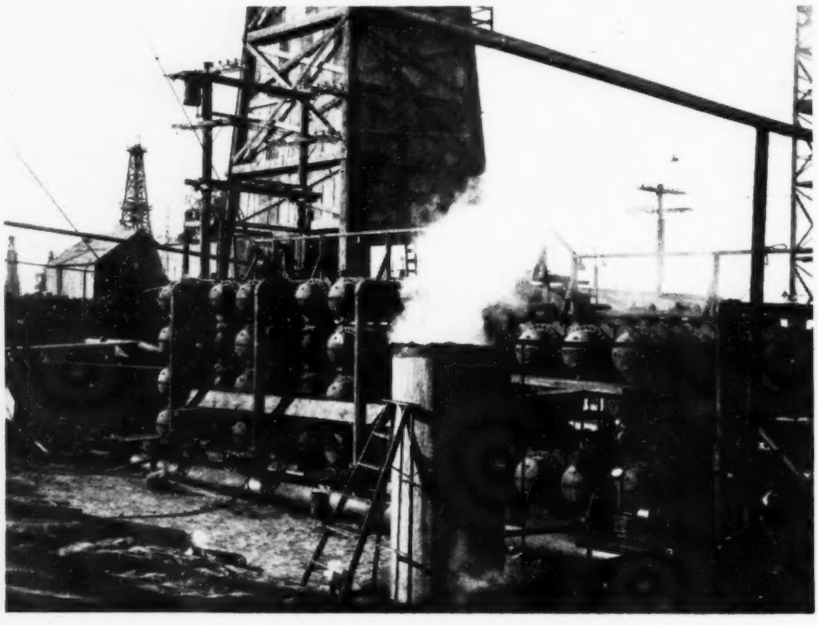
Because of the uncertainty of uniform results and handling hazards involved, the use of raw commercial acids for this work is diminishing. These factors also account for the specialized research that has been done during the last few years resulting in the development of inhibited acidic materials that, due to their effective yet controlled uniform de-scaling action, provide new standards of safety and uniformity in results on a wide range of lime-scale removal work. They not only do a better job than is possible with raw commercial acids, but in addition do not appreciably attack underlying base metal surfaces of heat exchanger tubes.

The newer, safer acidic materials developed for this work may be applied in either of two ways. After the proper solution has been prepared, it is introduced into units. Then it is permitted to "soak" or is circulated through the system, depending upon the particular type of equipment being treated, the character and extent of the lime-scale deposits present, and other operating conditions. Simple measures are taken for proper venting of equipment to take care of gases generated in the de-scaling operation. After a specified period of time during which the de-scaling solution has performed its work, which is determined by inspection at intervals and titrating of solution, the unit is drained, neutralized, and thoroughly rinsed.

Cleaning enters into so many different types of salvage and maintenance work common to oil refineries and natural gasoline plants that it is impossible to include all these various operations here. Nevertheless, the types of work cited are common to many plants and give an indication of what modern materials and methods, backed by competent laboratory and field engineering service, are doing to help the refining branch of the petroleum industry economically solve its equipment reclamation and maintenance problems and thereby make essential equipment units, parts, and supplies give much longer service.

☆ ☆ ☆

Bank of heat exchangers being cleaned by circulation method, which by eliminating need for dismantling, keeps shut-down time at minimum so that units can be put back into service quickly. Cylindrical tank containing hot cleaning solution is in foreground. Pump for circulating solution through tubes appears in lower right-hand corner



Crowding the turns can mean trouble in piping, too!

When they're riding hell-bent for leather . . .

LOOK OUT! Rounding the turn into the stretch is the place where horse races can be won or lost. A horse gets "pocketed." A rider is jostled. Because there's *added* danger at the turns, anything can happen! TURNS are crucial danger spots in piping systems, too! That's why welding with Tube-Turn fittings is sounder practice wherever pressure and strain are liable to cause leaks, breaks, or pipe connection failures of any kind. There is a Tube-Turn fitting to protect and strengthen *every* piping turn—all types, sizes and weights—returns, elbows, tees, reducers, laterals, nipples, caps, saddles, and flanges.

Write for helpful engineering data book and catalog.

TUBE-TURNS, Inc., Louisville, Ky. *Branch offices:* New York, Chicago, Philadelphia, Pittsburgh, Cleveland, Tulsa, Houston, Los Angeles. *Distributors in all principal cities.*

TUBE-TURN TRADE MARK

The FIRST WELDING FITTINGS 1ST AND STILL THE BEST

Welding Fittings

WHEN THE "PRESSURE'S ON" TUBE-TURN FITTINGS WILL GIVE FULL PROTECTION

In this compact, streamlined assembly, welded pipe lines and Tube-Turn fittings *(indicated by check marks)* will harness wild, live steam in one of America's large industrial plants. A failure at any point here would mean more than stopped production and lost man hours. It could mean terrific damage, perhaps loss of life. But Tube-Turn welding fittings give *added protection* where it's needed—at the turns!

Butane as a Source of Motor Fuel Volatility

PETROLEUM ENGINEER EXCLUSIVE Feature

☆ **Increased demand for butane in the manufacture of 100-octane gasoline and synthetic rubber presents problem of providing another source of motor fuel volatility—Propane may be the answer**

by James W. Vaiden, Vice-President,
and
Justus O'Reilly, Refining Department, Skelly Oil Company

BUTANE, long a main source of motor fuel volatility, is a petroleum product for which the most drastic changes in utilization are in prospect. Demand for this product was undergoing marked change even before the impetus of its greatly expanded demand as raw material for 100-octane gasoline production and synthetic rubber manufacture. The time has passed when refiners, after including all the butane in motor fuels permissible under existing specifications, diverted a substantial amount to residue gas for refinery fuel, especially in the summer months. Polymerization units, both catalytic and thermal, were developed to convert butane fractions into heavier products, polymers, which retained the high octane values of butanes, but had a vapor pressure and a boiling range within that of gasoline. By these processes, butanes, which as fuel had very little value, were converted into gasoline fractions of much more than average motor fuel value because of their ability to save lead in motor fuel blends. A large number of polymerization units are now in use, consuming considerable volumes of butane that formerly were largely used as fuel.

Increased use of butane and butane-propane mixtures for industrial and residential fuels in localities not served by natural gas systems has accounted for additional profitable butane utilization in recent times. Another expanding market is found in use of butane alone as a motor fuel, made possible by installing fuel and carburetion systems especially designed for this high-octane, high-vapor-pressure petroleum fraction.

Use in Motor Fuel Blends

The abovementioned uses for butane are not nearly so important as is its use in motor fuel blends. Refiners have also increased this use by more nearly complete depropanization of motor fuels through improved fractionation. For example, reduction of propane content of motor fuel by 0.5 percent has permitted inclusion of an additional 1.5 to 2.0 percent of butane to give the same finished vapor pressure.

There is another side to the story, however. All the time that the refiners have been exercising their ingenuity to create outlets for butane that are more profitable than use in the refinery fuel system each summer, they have been increasing their own dependence upon butane. This fact is being painfully brought home as the demand for all butane fractions for manufacture of both aviation fuel and synthetic rubber continues to increase at a drastic pace. Just what will be the total demand for butanes by these two war industries cannot be stated, but Nelson* estimates that combined requirements may be very nearly the total butanes available—129,000 B.P.D. —in producing 130,000 to 150,000 B.P.D. of 100-octane aviation fuel and 400,000 tons per year of synthetic rubber. As definitely greater production of both these commodities is be-

*Oil and Gas Journal, January 22, 1942.

J. W. VAIDEN

received a chemical engineering degree from Alabama Polytechnic Institute in 1921 and for several years thereafter taught mathematics—Was employed by the Skelly Oil Company in 1924, initially being employed as a linewalker, later as gasoline plant engineer, then plant superintendent—When in 1933 the gasoline plants of the company were placed under the jurisdiction of the Production Department he was made manager of natural gasoline manufacture—In 1936 he was elevated to the post of general superintendent of the Natural Gasoline-Natural Gas Division and a year later to the position of manager of that division—In the Spring of 1941 his duties were enlarged to include the company's refining activities, and in June of that year he was made vice-president in charge of manufacturing.

JUSTUS O'REILLY

received the degree of B.S. in chemical engineering from Kansas State College in 1935 and since that time has been employed by the Skelly Oil Company, serving in the refinery at Eldorado, Kansas, as laborer, laboratory tester, operator's helper, assistant in the Engineering Department, process engineer, and foreman of the treating plant—Since the Fall of 1941 he has been in the Tulsa, Oklahoma, office of the company as an assistant in the Manufacturing Department.

We're counting on them...

and they're counting on us!

WE'RE counting on our armed forces to win the greatest war in history.

They're counting on us for the ample supplies needed for modern mechanized warfare.

The production lines in America's factories are turning out the world's finest mechanized equipment. Refineries throughout America, using the Furfural Refining and Solvent Dewaxing Processes, are turning out the world's finest oils to lubricate this equipment and keep it rolling to victory.

TEXACO DEVELOPMENT CORPORATION

A Subsidiary of The Texas Company

26 Journal Square • Jersey City, N. J.

ing seriously contemplated, it is obvious that substantial diversion of butanes for all current uses is possible, and even probable.

Availability of Butane

It should be remembered that much of our total production of butanes, and good octane straight-run naphtha as well, which theoretically could be raw material for aviation fuel production, are actually not available for practical reasons. Alkylation and isomerization processes require very high investments, and installation of small units are not at present economically feasible because small capacity units require volume production. The critical needs for steel in all industries will tend to restrict the construction of units for the manufacture of aviation gasoline to areas in which raw materials are available in large quantities, so that the most economic use possible may be made of steel supplies allocated to such construction.

The factor of size-limitation should have the effect of keeping for present markets much of the butanes now produced by refineries and natural gasoline plants with small outputs. Some of these may be able to transport raw materials to large centrally situated plants, but most of them will probably use their butane to supply markets formerly served by sources that are being diverted to 100-octane fuel production.

In other words, the refiner who has only recently developed sufficient outlets largely to obviate the wasteful practice of burning his butane as refinery fuel may now find himself without the butanes to satisfy the market demands he has so painstakingly created. Preliminary investigation in our own refining operations indicates that we should be quite short on butanes if we should be required to manufacture aviation fuel; especially would we be short of regular motor fuel blends. The butenes—the butane fraction that can be catalytically polymerized—will be needed for alkylation production. *Iso*-butanes are also needed for alkylation, and because of limited quantities of this fraction, much of it must come from isomerization of normal butane.

The result of this withdrawal of butanes from peace time markets to war industry is serious in each marketing field affected. In the heating field, conversion of butane systems to use of propane is hampered by the inability of most butane equipment to stand the higher pressure propane would require; and steel for new tanks of higher pressure and appurtenances capable of handling propane will possibly not be available. Loss of butanes from polymerization charge stocks to alkylation plants raises the question of how motor fuel anti-knock quality is to be obtained—this to an industry that for several months has been confronted with the problem of tetraethyl lead curtailment. Even the lower octane ratings made necessary by restricted lead supply may be too high for refiners to attain if polymer gasoline is lost to them because of butene requirements of alkylation.

Restricted butane supply for use as motor fuel "straight" would create peculiar difficulties. Most users of commercial butane as motor fuel are fleet truckers, having units equipped with the special fuel systems required for this high vapor pressure, good anti-knock fuel. Wholesale conversion of these units to burn conventional motor fuel would likely require both parts and mechanic man-hours that are needed elsewhere. As a practical matter any butane supply restriction that would handicap transportation facilities will probably be avoided at this time.

Motor Fuel Volatility

Although restriction of butane supply to any of the abovementioned outlets would present serious difficulty, the most difficult problem that a shortage could cause is probably that of motor fuel volatility. Removal of all butanes from motor fuel would lower the vapor pressure by approximately 4 lb., assuming the average butane content of motor fuel to be 6 percent. A decrease in finished vapor pressure of 4 lb. would result in a decidedly unsatisfactory motor fuel from the volatility angle. Complete removal of butane would also most certainly lower the anti-knock value to a critical point. The seriousness of the effect of complete butane deletion from motor fuels would vary in degree with different fuels and with seasons, but in all cases would be great.

Refiners can be reasonably certain that the aviation gasoline and synthetic rubber programs will not absorb all butanes, but these programs will require a very considerable part thereof. With this certainty in mind, a most pressing question regarding motor fuel volatility must be considered: What shall we substitute for butane, and where shall we find this substitute?

A principal volatility source in the past has been natural gasoline. In the volatility shortage we are now anticipating, natural gasoline is more likely to present added problems than it is to offer a satisfactory solution. Improved fractionation of natural gasolines is already being practiced to procure *iso*-pentane and *iso*butane for use as blending agents and raw material for processing, respectively, in making aviation fuel. Supplies of natural gasoline for use in increasing motor fuel volatility will be reduced by the removal of these fractions. Moreover, such natural gasoline as will remain to motor fuel will be markedly lower in anti-knock value, and hence will likely complicate further the tetraethyl lead problem.

Mid-Continent refiners who have in the past drawn on natural gasoline from the Texas Panhandle area for their motor fuel volatility may quite conceivably see supplies from that area curtailed for an additional reason. Much of this natural gasoline is produced from sour gas reservoirs, with the natural gas finding a market in the carbon black industry. Carbon black is largely—90 percent—consumed in the manufacture of tires, and we may reasonably expect a considerable lag in tire production between the time of almost complete cessation of raw rubber imports and the time a full-scale production of synthetic rubber is achieved. Carbon black production almost certainly will be sharply curtailed during this tire-production lag, and with this curtailment the market for sour natural gas will disappear and production of natural gasoline from the sour gas reservoirs will cease.

It is probable, therefore, that refiners will not be able to replace butanes diverted to war industries with natural gasoline for motor fuel volatility, because the supply of natural gasoline itself may logically be expected to decrease, both by diversion of *iso*butane and *iso*pentane to aviation fuel and by stoppage of production from sour gas wells.

Other Volatility Sources

The refiner then must look to other sources for volatility. Substitution of propane for butane can be done to some extent. It may be that distillation specifications that now limit the use of propane in lieu of butane will be revised due to urgency of the volatility need. In such an event, refiners might be able to hold their finished motor fuel to essentially the same finished vapor pressure with propane as they now have by using butane. Such a blend perhaps would be a satisfactory motor fuel so far as volatility is concerned, but would be inferior in anti-knock quality.

Additional volatility possibly can be had by operating changes that the refiner himself can make. Better fractionation and improved vapor recovery operations in general can be utilized to increase the total recovery both of butanes and propanes.

The investment required to effect the close control and efficient separation that are requisite to improved recovery and purification of these prod-

THE NEW STAR IS

WYTEFACE "A"!

Once again steel tapes have been improved—and by the same house that has led in measuring developments for the past three decades! This time it's WYTEFACE "A"—a new type of WYTEFACE Tape with *raised* black metal graduations on a crack-proof white surface; easy to read as a newspaper headline; with an uncanny resistance to abrasion that greatly prolongs its useful life. Constant wiping, abrasion with oil and sand, or scraping on the pipe pile have no terrors for this improved steel tape!

WYTEFACE "A" is the result of constant research. Less than thirty years ago all steel tapes were shiny —until K&E developed the well-known Keco finish to provide contrast for the numbers and graduations. In 1935 this same research produced the famous WYTEFACE line, with easy-to-read graduations marked directly on a crack-proof white surface. It is but one logical step to WYTEFACE "A" with its increased resistance to abrasion, designed particularly for oil field service!

There are K&E WYTEFACE "A" Steel Tapes in all sizes and types—in cases or on reels—for every job in the oil industry. You will find them stocked by every leading oil well supply company. Ask your dealer—or write for a catalog.

EST. 1867

KEUFFEL & ESSER CO.

NEW YORK • HOBOKEN, N. J.

CHICAGO • ST. LOUIS • SAN FRANCISCO • LOS ANGELES • DETROIT • MONTREAL

K&E

WYTEFACE "A"

TRADE MARK

STEEL TAPES

ucts may not have been economically justifiable in the past, because the fractions already being recovered were partially burned as fuel during the warm season, and built-up inventories of natural gasoline could be depended upon to supply volatility throughout the winter months.

This situation will change when the substantial diversion of butanes from their normal outlets is accomplished. All butanes, but especially butenes, will be at a premium, and investments for improved fractionating equipment, which could not previously be justified, will become a necessity. It is possible that the refinery that is not participating in one of the war industries will not be able to obtain the equipment, but this refinery will have the least need for it. Such a plant—and in fact all plants—possibly could improve to some extent the recovery of butanes and propanes with the existing equipment, if the demand for these fractions increased enough to pay for the increased operating effort. In these two ways—erection of more efficient facilities and more efficient operation of existing facilities—refiners may greatly help themselves in the solution of their volatility problem.

A change in the demand-supply balance of refined products may help somewhat in alleviating the volatility shortage by causing changes in refinery operations beyond simply more efficient vapor recovery and separation. The need for butenes probably will dictate changes in cracking-products balances. Increased reforming of straight-run gasolines to swell yields of cracked gases may be practiced generally. Both the decrease in total motor fuel yield and the diversion of straight run to reforming (which will take out of motor fuel a low vapor pressure component) will reduce somewhat the need for volatility. The lower total yield of motor fuel will logically be helpful in the refiners' overall picture also because of the slump forecast in non-defense sales due to tire shortages.

All in all, it may be hoped that although volatilizing agents now in general used will certainly be scarce in months to come, the refiners will be able to meet market needs as they arise. The abovementioned possibilities —use of propanes, maximum recovery by improved fractionation, and change in plant operations to increase yields of volatile products—all can help the refiner to supply market demands adequately, and at the same time continue production of a satisfactory motor fuel blend.

These possibilities and others, however, should be thoroughly investigated now, so that adequate plans may be made for the future. For example, if a particular plant expects its butanes to be absorbed eventually in the manufacture of aviation fuel, consideration should be given now to the problem of where to go for replacement material that will supply adequate volatility for the butaneless motor fuel, and plans for preparing this replacement material should proceed along with plans for the new butane-consuming processes. Otherwise an "in-between" period during which no really satisfactory motor fuel blend could be made might easily result.

Summary

In summary then, we might say that these items stand out, as disclosed in relation to our own problem:

1. A large share of our total butanes will in future not be available for our present butane outlets — polymerization, industrial and residential fuel, and motor fuel blends.

2. The most serious problem due to butane shortage is likely to be lack of motor fuel volatility, because such butanes as may remain will be needed for pressure motor fuel and industrial-residential fuel systems that, at this time, cannot be readily converted to other fuels.

3. We may be able to replace entirely the diverted butanes with propanes, within the limits imposed by motor fuel specifications.

4. Natural gasoline will probably not be a butane substitute upon which we can depend.

5. Greater demand for butane and propanes will justify increased investment and more precise operation in order to effect better recoveries and separation.

6. Changes in product balance in markets, and demand for butenes, will lower the total demand for motor fuel volatility, and so help in solving the problem of blending satisfactory motor fuels without butanes.

☆☆☆

P 028.1

Proposed Revision of A. S. M. E. Code for Unfired Pressure Vessels

ANNOUNCEMENT has been made of a modified plan for the revision of Section VIII of the A.S.M.E. Boiler Construction Code. The Special Committee of the Boiler Code Committee to Revise Section VIII has completed a preliminary draft of the proposed revision. The general arrangement of the draft is quite similar to that followed by the A.P.I.-A.S.M.E. Code for Unfired Pressure Vessels. The important changes between the present Section VIII and the proposed revision can be briefly summarized as follows:

1. The uses to which vessels constructed under a given set of requirements can be put on account of the difference in the hazard involved, which are now specified in Paragraphs U-68, U-69, and U-70, have been eliminated except for vessels containing lethal liquids and gases that are required to be both stress-relieved and radiographed.

2. The efficiencies of fusion-welded joints are the same as given in the A.P.I.-A.S.M.E. Code.

3. The rules for determining the shell thicknesses of vessels include an additive thickness for corrosion designated by c in the formulas. The added thickness c may be zero when previous experience has shown that corrosion does not occur. For air, steam, and water vessels, c is to be made equal to $t/6$, except it need not exceed $1/16$ in.

4. Provision is made for a minimum factor of safety of four for vessels constructed of steel plate.

5. Appendix A will contain recommendations that will not be mandatory for periodic inspection, repair and maintenance, and allowable safety valve settings for vessels in service. They are adapted particularly to the oil-refining industry.

6. Mandatory rules have been included for trepanning specimens from the main welded joints, when such vessels are not radiographed and have plate thickness in excess of $\frac{1}{4}$ in. Local radiographic examination of the welded-seam may be substituted, however.

7. Premiums are allowed for the work performed on the vessel, the greatest premium being for a vessel that is radiographed. When mandatory stress relieving and/or radiographing is not required either or both of these operations may be performed and the premiums used accordingly.

8. The hydrostatic and proof tests follow closely the requirements of the A.P.I.-A.S.M.E. Code.

☆☆☆

P 753.

PETROLEUM ENGINEER Exclusive Feature

Refinery Practice for the Operating Man

Vocational Class Proceedings in Refinery Engineering

Manufacture of Lubricating Oils

THIS installment begins a series on the manufacture of lubricating oils. The text used is *Modern Methods of Refining Lubricating Oils* by Vladimir A. Kalichevsky, published by Reinhold Publishing Corporation, 330 West Forty-second Street, New York, New York.—Editor's Note.

Class Meeting No. 1

Leader: In beginning this class on lubricating oils, it might be well to obtain some idea of the first lubricants. A few thousand years ago, about the time the wheel was developed, if we saw a cart going along the road, do you think it would have been lubricated?

Pupil: I suspect that it might not have been; you might think so, for this reason: Just recently in Jerusalem, a rather energetic Jew came in and saw a business opportunity. He brought in some greases and sold them to the people to use on those old carts that they are still using. The grease stopped the squeak or music in the wheels so much that it vexed the inhabitants, because they depended on those carts coming in early in the mornings to awaken them. This Jew was then very unpopular because he interfered with what they regarded as their alarm clocks.

Leader: Eventually we came to a period when wheels were lubricated, and when they were, what lubricants were used? Do you remember?

Pupil: Some of the remains found of the Egyptian civilization indicated they used pitch.

Leader: Did they use it on stone or wooden wheels?

Pupil: Wooden wheels.

Pupil: I read that about 100 years ago they used sides of bacon to grease journals in a machine shop.

Leader: You are getting more modern.

Pupil: Animal fats were most widely used.

Leader: I think so.

Pupil: I think the most widely used axle greases were soaps.

Leader: Those were made many centuries ago.

Pupil: When those tombs in Egypt were opened a number of years ago, they found saponified fats or soaps had been used on chariot wheels.

Leader: About 3000 or 4000 years ago?

Pupil: It was B. C.

Leader: What were some of the other lubricants used?

Pupil: Whale oils.

Leader: When did we begin pressing vegetables for castor oil, etc.? Is castor oil a recent lubricant? Are we agreed that vegetable oils were superior?

Pupil: In many cases they were easier to keep in contact with the axles.

Leader: Why were they? You could get by on slow-moving machines with those lubricants; however, all these oils are in the general classification of fixed oils. By fixed oil we mean an oil that can't be distilled without decomposition. Since that is the case, use of it to lubricate an internal-combustion engine would result in trouble as heat was applied. Was castor oil used for airplane engines during the World War?

Pupil: Yes.

Leader: So we can't make too wide a generalization with regard to them, but we can in part.

Pupil: Isn't castor oil still used?

Leader: Yes. It is on the decline, however, for certain reasons that we shall not attempt to discuss now. What characteristic of an oil is there that you think would be very important for internal-combustion engines?

Pupil: The temperature-viscosity relationship.

Leader: This temperature-viscosity relationship—why is that important?

Pupil: Without knowing the proper temperature-viscosity relationship you are likely to use an oil that will give too heavy or too light a film and not the proper lubrication.

Leader: What will happen if it is too light?

Pupil: It will permit the bearings to wear; if it is too heavy there is too much friction.

Pupil: You would have wear if it were too heavy, or so heavy that it wouldn't get to the pump and into the bearings.

Leader: How many times do you happen to recall seeing an engine with too heavy an oil that automatically developed clearance for that heavy oil, and later tried to use a light oil in it? How about oil being so thin that it will get past the piston rings and into the combustion chamber?

Pupil: It might have leaked past the rings 10 or 15 years ago when the finish and machine work on automobile motors were poorer.

Pupil: Heavy oil will get past the piston rings quicker than light oil.

Pupil: I was under the impression that the strength of the oil film did not have any relationship to viscosity.

Leader: You would have to define the conditions.

Pupil: There is a theory that thin oil film will rust more quickly. I have heard that thin oil will give better lubrication if you can keep it in there.

Pupil: Doesn't that depend upon the type of mechanism you are lubricating? For instance, in bearings where the pressure of the lubricant is depended upon to maintain the separation of the two metal surfaces. In a heavy machine you would depend more upon the film strength of the oil itself to maintain the separation of the two metal surfaces.

Pupil: The surface tension of your oil might have some effect, too.

Pupil: I should think the temperature stability of the oil—not to oxidize or decompose—would be important.

Pupil: Before we go too far, do you think pour point should be mentioned? Some wear conditions are definitely dependent on pour point.

Pupil: I should think that would include all types of stability. You spoke once of mixing two different kinds of oil that formed a sludge, and that would be another form of instability.

Pupil: I think stability should head the list and oxidation next.

Pupil: Do you want some additional ones?

Leader: Yes, under stability. Instead of being too technical, we can consider other types.

Pupil: Corrosion would come under stability, wouldn't it?

Leader: Corrosion is considered so important that several books have been published on the subject. What shall we say? To avoid corrosion, and what else?

Pupil: Film strength.

Leader: Could you use water for a lubricant?

Pupil: It has been used.

Leader: Suppose it were a steam engine cylinder instead of an internal-combustion engine cylinder, could you use water as a lubricant?

Pupil: Some pumps in the field have run for years without lubrication.

Pupil: Yes, but they'll last longer if you put in a little oil.

Pupil: Water will lubricate as long as you keep it between the metallic surfaces.

Pupil: Doesn't that depend on film strength and the cohesive and adhesive properties of the film? Water will not adhere to the surface so readily as oil.

Pupil: By film strength, I mean the amount of pressure that can be put on the film without rupture.

Leader: You mean the ability to keep the two metals separated, is that right?

Pupil: Yes.

Leader: What else do you think of?

Pupil: Flash and fire points.

Leader: Why is that important?

Pupil: I suppose that operating conditions would govern flash and fire, but there is one reason why the industry considers it important and that is the storage conditions, along with the fact that it is desirable to reduce volatility along with flash and fire. The minute the lubricant gets in the engine, it is contaminated by gasoline, thus the flash and fire is ruined.

Pupil: That is true with crankcase oil, but if you have an engine that is using no oil beyond the normal consumption ratio and you get your flash point down too close to the internal temperature of the engine, distillation takes place in that engine.

Pupil: Don't you think flash and fire are probably valuable due to being an indication of careful refining?

Pupil: You are talking about an oil you want to make; if it has a low flash and a peculiar fire, the chances are it is poorly refined.

Pupil: I wish to bring up the fact that oils have been purposely diluted before use.

Pupil: Should steam emulsion and demulsibility be listed as an important characteristic of a lubricant for internal-combustion engines?

Pupil: If we were going to run a marine engine, we would want some sort of demulsibility test.

Leader: Can you think of anything else?

Pupil: Carbon residue.

Leader: What difference does that make?

Pupil: Carbon is deposited on the pistons. Sometimes it is a form of varnish—some of it is hard and some of it is flaky.

Pupil: What about "oiliness"?

Leader: Do you think that is important?

Pupil: Yes, but I don't know how to define it.

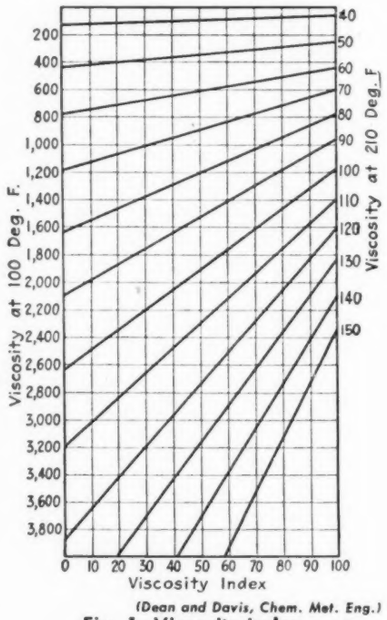
Pupil: Wouldn't it have some connection with film strength?

Pupil: Another factor that helps to sell oil is bloom or color.

Pupil: Perhaps it has no real value in the oil, and has nothing to do with lubrication, but it has something to do with customer satisfaction.

Leader: Now to summarize, we have listed the following as important characteristics of the internal-combustion lubricant:

1. Temperature-viscosity relationship and pour point
2. Stability
   a. Oxidation
3. To avoid corrosion
4. Film strength



(Dean and Davis, Chem. Met. Eng.)

Fig. 1. Viscosity index

5. Flash and fire—volatility
6. Emulsion and demulsibility
7. Carbon residue
8. Oiliness
9. Color and bloom

Pupil: The author of our text mentions viscosity gravity constants.

Leader: We shall discuss viscosity. Is there any question in anyone's mind about the meaning of viscosity index?

Pupil: Why do we persistently continue to use indices and then go clear beyond the original limit of those indices? Why don't we get a new index?

Leader: That would be comparable to changing the value of the dollar and would involve changing our system of evaluating lubricants.

Pupil: There is never any hesitation about changing octane numbers.

Leader: There has been some hesitation on that, I think.

Leader: Do you think the public understands viscosity index?

Pupil: No.

Pupil: The jobbing trade thinks it should be high, but do you think it means anything to the customer?

Leader: I don't know—this viscosity index is just a yardstick.

Pupil: There are still several different methods of temperature viscosity relationship, aren't there?

Leader: Yes, I will remind you that in *Nelson's book on page 76, there is a chart that helps convert to viscosity index number. I will assume there is no question on viscosity index then, and it is merely a system of identification.

Pupil: I should like to hear some more about it.

Leader: The zero of the scale indicates one of the Gulf Coast lubricants. An oil with such poor viscosity index would be hard to start in cold weather because it is so thick, and in hot weather it would go past the piston rings and into the combustion chamber. Mid-Continent oil has an index of 75-80, so the engine would be easier to start, and the oil would go through the engine more freely. Pennsylvania oil is selected as the top of this scale and is 100.

		V.G.C.	*V.I.*
(Paraffinic)	Pennsylvania	0.812	105
(Naphthenic)	Gulf Coast	0.885	18

Oils of this type (pointing to Pennsylvania oil in the above table) that once were called 100 percent paraffinic by solvent refining and removal of some of the objectionable materials, are now brought up to 125.

Pupil: Several years ago there was some discussion concerning viscosity index, and I believe it would be well here to discuss why lubricating oil fractions are not made from cracked products. I was just wondering whether someone remembers that discussion. The answer is simple, but the fact remains that it does bring out an example, and the yardstick still applies. Of course, you could hydrogenate and still get the proper viscosity index number.

Class Meeting No. 1 will be continued in a subsequent issue.

☆ ☆ ☆

Petroleum Refinery Engineering by W. L. Nelson.

Synthetic Rubbers to Meet Requirements of Natural Rubber in Industry

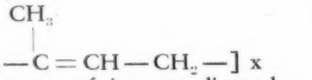
PETROLEUM ENGINEER Exclusive Feature

☆ Qualities and characteristics of synthetic rubber — Butadiene appears to be most important of synthetic rubber base materials

by C. C. Pryor, Assistant Editor

IN 1860 an Englishman found that the fundamental hydrocarbon unit, from which rubber is made, was an organic compound, which he named "isoprene." Isoprene is today known as one of the simpler members of the diolefine family or one of the members of the hydrocarbon group having two double bonds. Isoprene has the following structure:

The natural rubber molecule may be considered as a large number of isoprene units, as:



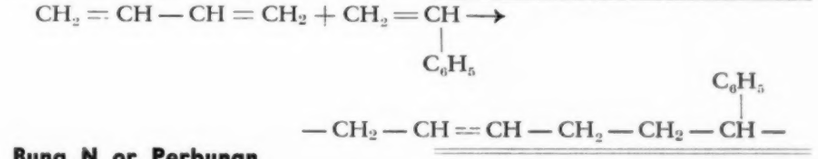
The discovery of isoprene directed the research of chemists along the line of rubber synthesis. It was not until 1884, however, that the first synthetic rubber was made. Sir William Tilden found that isoprene could be made from turpentine and then polymerized into rubber—a synthetic rubber. Polymerization of isoprene into the rubber-like material is not a true rubber synthesis in all respects. The polymerization to similar substances that have properties that are superior and some that are inferior to natural rubber can be accomplished with other petroleum hydrocarbons or their derivatives such as butadiene, dimethyl butadiene, chloroprene, and the butenes. Numerous synthetics are manufactured today. Most important as base materials are the C_4 hydrocarbons, which may be seen in increased activity in the manufacture of C_4 diolefines by the dehydrogenation process.

Buna S

In the early 1900's synthetic rubber made its first important step. Isoprene was neglected for the study of more readily available members of the diolefine group. As a result it was discovered that butadiene, which is isoprene minus a methyl group, and dimethyl butadiene could be made into synthetic rubber by heat in the presence of sodium. This new synthetic rubber was called Buna from the butadiene and natrium.

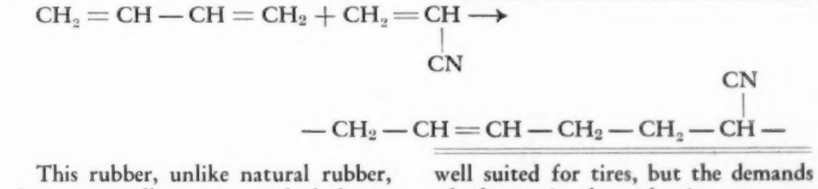
By 1926 it had been found that the polymerization of butadiene in the presence of sodium was unsatisfactory and a new process was found. Addition of certain modifying agents to the butadiene and a different method of polymerization being employed resulted in a superior rubber. These modifying agents are styrene ($CH_2 = CH$, vinyl benzene) and acryle nitrile ($CH_2 = CH - CN$, vinyl cyanide).

Mixing the styrene with butadiene, emulsified in water along with the diolefine, and treating with a catalyst results in Buna S. The typical reaction of this copolymerization of butadiene and styrene is as follows:



Buna N or Perbunan

When the acryle nitrile is used in place of the styrene the resulting synthetic rubber, Buna N or Perbunan, is even more satisfactory than Buna S. This copolymer of butadiene and acryle nitrile has the following typical reaction:



This rubber, unlike natural rubber, does not swell to any marked degree when in contact with oil. Thus it is well-suited for gaskets, diaphragms, printer's rollers, gasoline hose, etc. It possesses excellent resistance to solvents and oxygen, high strength with carbon black, medium elasticity, and handling characteristics so difficult that it can not be used for tires without modification.

Neoprene

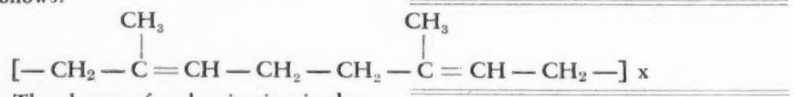
Along with Buna rubber's discovery in 1926 came Neoprene or Duprene as it was called when discovered by Nieuwland and Carothers. Here again a new step was taken. Natural rubber contains no chlorine, but Neoprene is made by polymerizing chloroprene, which is isoprene with a chlorine atom replacing the methyl group. This polymer of chloroprene is made from vinyl acetylene and is not yet derived from petroleum sources. A typical unit of the polymer is as follows:

The polymerized chloroprene material is very similar to crude rubber in appearance. Rubber companies mix it with other ingredients, process it and vulcanize it into many products in the same way crude rubber is mixed, processed, and vulcanized. Neoprene satisfies a basic need for a material having the elasticity, strength, resilience, and abrasion resistance of rubber, and yet maintains these properties despite exposure to oils, chemicals, heat, sunlight, ozone, and aging. Neoprene is well suited for tires, but the demands of the national production program using more than three-quarters of a million lb. each month in gasoline tank linings, cable coverings, aircraft parts, etc., has limited its application up to the present time. In 1941 the automobile and aircraft used it in more than 100 parts.

Butyl Rubber

Natural rubber contains a large number of isoprene units and each unit contains two double bonds (diolefines). When isoprene or any of the group of monomers used in making synthetic rubber are polymerized, they link with themselves forming a very strong, straight polymer chain; however, only

one of the double bonds of the monomer is used in the forming of the chain and the other is left free. A portion of a rubber molecule may be as follows:



The theory of vulcanization is that the sulphur used in vulcanizing links the molecules of the rubber together through the double bonds, however, it has been found that for the very best vulcanized rubber only 1 to 3 percent of sulphur is needed indicating that only a few of the double bonds present in the molecule are saturated by the sulphur. Therefore, a great many of the double bonds are left inactive. It is believed that the corrosion of rubber is due to the action on these free double bonds of acids, strong chemicals, oxygen, ozone, etc.

Several years ago chemists of one large company began a close study of the double bonds and on the basis that, as only 2 percent of the unsaturation of natural rubber was used in vulcanizing, that was all that was required, and the additional bonds were unnecessary. This group turned to the olefines rather than to the diolefines. Very little of the diolefines was used, only enough to give the minimum unsaturation to permit vulcanizing.

As a result the rubber that was produced from this process, Butyl rubber, had only one-hundredth the unsaturation of natural rubber and was still vulcanizable. After vulcanizing the rubber is substantially saturated and possesses no double bonds to be oxidized, ozonized, or corroded by chemicals.

The designation *Butyl rubber* applies to a 100 percent hydrocarbon product from olefinic and diolefinic constituents. It has a molecular weight in the general range of 40,000 to 80,000 as determined by viscosity measurements on dilute solutions. It is colorless, odorless, and tasteless. It resembles crepe rubber in appearance, and as it is an aliphatic hydrocarbon polymer, has a low density approaching the minimum attainable for elastic materials of this type of 0.91 gm. per cu. cm.

When vulcanized, Butyl rubber has the chemical stability of the paraffin hydrocarbon. It can be processed very much the same as natural rubber. No special treating or mastication is required and it is ready for pigmenting or vulcanizing as soon as it is turned from the mill.

It has been reported that tire-tread compounds made with Butyl rubber are much more resistant to dynamic flexure and lose little of the resistance after aging, due to its exceptional resistance to flexing. Natural rubber fails under such conditions. Abrasion tests made in the laboratory show that Butyl rubber reinforced with carbon black is greatly superior to natural rubber in abrasion resistance.

As a gas barrier, Butyl rubber is far superior to natural rubber as was found by tests carried out with hydrogen, helium, nitrogen, and sulphur dioxide.

Ameripol

Ameripol is a product from butadiene and other materials, however, more information on this synthetic rubber is not available. Indications are that this synthetic rubber can be fabricated into tires with the same machinery used for natural rubber. The molecules of butadiene contain four carbon and six hydrogen atoms. These molecules are easily polymerized with each other or copolymerized with other substances. The polymerization is speeded up when the butadiene is emulsified under pressure with soap and water with the resulting product a milky suspension similar in some aspects to natural latex. The suspension is then coagulated with acid as is natural rubber and sheeted to produce the synthetic rubber.

Ameripol can be processed by using any of the standard rubber procedures. Accelerators have almost the same effect on this synthetic as on natural rubber. Usually larger amounts of softener are necessary, which aids in the processing.

This synthetic possesses almost complete resistance to swelling due to oils, gasoline, etc. Good adhesion to metals and very low permeability to gases are also qualities.

Chemigum

Another of the butadiene copolymers is the synthetic rubber, Chemigum. The material replacing styrene or acryle nitrile is not known, however, Chemigum is made in three grades of hardness, Chemigums I, II, and III. Comparatively tough and with a distinctive odor, Chemigum resembles brown crêpe grade rubber in appearance.

Chemigum is either equal or superior to natural rubber as regards tensile strength, abrasion resistance, aging, and resistance to sunlight.

Thiokol

Thiokol is similar to natural rubber in many respects, surpassing it in some respects, but inferior in others. This synthetic rubber is known as one of the organic polysulphide rubbers. Included in the group are types A, B, D, F, FA, and RD that are similar to natural rubber because they must be compounded, processed, and vulcanized to obtain full advantage of their qualities.

Thiokol is produced through the interaction of organic halides or chlorides with inorganic or metallic polysulphides. Generally, a condensation or polymerization is involved resulting in molecules of high molecular weight. Because this reaction is not limited to a single halide or polysulphide numerous different polymers may be obtained and by copolymerization even more variations are possible.

Thiokol possesses good elastic qualities and excellent resistance to solvents; but lacks in strength, toughness, and resistance to heat as compared to natural rubber. It is chiefly used for special purposes by its manufacturer. The organic polysulphide rubbers are practically unaffected by gasoline, or lubricating oils.

Vistanex

Polymerizing *iso*butene produces a material similar to rubber in many respects. The most outstanding difference is that it cannot be vulcanized by conventional methods. Its trade name when first developed in Germany was Oppanol, but was named Vistanex after further research in the United States. *Iso*butene polymerization is conducted at relatively low temperatures using such catalysts as aluminum chloride or boron fluoride and has a reaction that is often completed in fractions of a second. The temperature of polymerization controls the molecular weight of this product. Density of Vistanex is about 0.91 gm. per cu. cm. The higher the molecular weight, the higher the tensile strength of this material. A molecular weight of about 200,000 in the material has a tensile strength of about 680 lb. per sq. in. after 5 minutes mixing on a cold open roll. This tensile strength was raised to 1900 lb. per sq. in. by milling at 140°C. for 20 minutes in a Banbury mixer. Pure polybutene has an elongation of about 1000 percent.

☆ ☆ ☆

Three years' production of synthetic rubber in the United States

Year	Type of synthetic rubber in tons: Neoprene	Butadiene	Polysulphide	Total
1939	1,750	00	500	2,250
1940	2,500	60	700	3,260
1941	9,000	4,000	1,400	14,400
Total	13,250	4,060	2,600	19,910

KEEP 'EM FLYING WITH

WAR LUBRICANTS

MODERN PROCESSES

MINUS 20° F.
POUR POINT AND OTHER
HIGH SPECIFICATION
LUBES

BY

including

- . . . SOLVENT REFINING
- . . . SOLVENT DEWAXING
- . . . SOLVENT WAX REFINING
- . . . SOLVENT DEASPHALTING
- . . . CONTACT FILTRATION
- . . . SULPHURIC ACID TREATING
- . . . HIGH VACUUM DISTILLATION

Complete lubricating oil plants engineered, designed, fabricated and built by FOSTER WHEELER

Foster Wheeler Corporation, 165 Broadway, New York, N. Y.

FOSTER FW WHEELER

Substitute Metals and Alloys for Refinery Uses

PETROLEUM ENGINEER Exclusive Feature

☆ Scarcity of many materials has resulted in a determined effort by metallurgical engineers to provide substitutes and minimize the use of certain elements and alloys

by B. B. Morton

Development and Research Division, The International Nickel Company

PETROLEUM refineries in the United States occupy a most important place in the war effort. They are called upon to supply toluene for explosives, 100-octane number gasoline for planes, and raw materials for the manufacture of rubber for tires.

Supplying these important items requires that suitable metals and alloys be used in the refinery equipment. So important are the three products that high priorities are allowed for purchase of the needed metals. The general shortage of many materials, however, is so keenly felt in refinery circles that, paced by excellent metallurgical staffs, a determined effort is being made to reduce to a minimum the use of certain elements and alloys.

Metallurgical Problems

To understand the trend in selection of substitute materials a review of the conditions dictating the use of alloys in refineries appears worthwhile. In general it may be said that alloys and special metals are used in petroleum refineries:

(a) To resist corrosion;

(b) To resist the action of elevated and reduced temperatures upon the mechanical properties of metals.

The two requirements are often necessary in the same pieces of equipment and fortunately many of the alloying elements can be utilized for both purposes.

Corrosion in refineries more widely dictates the use of alloys than does the effects of temperature.

A sharp dividing line for the use of corrosion-resistant materials in refineries exists at the temperature level where water can condense. Above this temperature sulphur attack is a factor and chromium must be present for the metals to offer corrosion resistance of appreciable order. The composition of the chromium-containing alloys will often show the presence of molybdenum. This element is added for a twofold reason. It inhibits temper brittleness in the chromium alloys and improves the resistance to "creep".*

Below the temperature level of condensation, electrolytic corrosion takes place due to the presence of water, and non-ferrous alloys are widely used to resist the attack.

It will be seen that alloys are used in refineries to prolong the useful life of parts and to reduce maintenance. They also contribute to shorter periods of "down time" as inspections need not be so detailed.

B. B. MORTON

was born in Pulaski, Virginia—During the first World War he was commissioned a second lieutenant while in France, and also served with the army of occupation—In 1921, he entered Virginia Polytechnic Institute, majoring in metallurgy—After graduation he worked for the American Smelting and Refining Company in Mexico, the Bethlehem Steel Company, the Standard Oil Development Company, and is now with the Development and Research Division of the International Nickel Company—Is a member of the A.S.M.E., A.P.I., and A.S.M.

*Creep is defined as continuous elongation in the direction of major stresses. It is usually evident at metal temperatures exceeding 700°F.

The curtailment of alloys, therefore, must lead to shorter life, greater maintenance, and more detailed inspection of parts. These evils must be endured as a contribution to the war effort.

The work of the engineers concerned with material often involves finding a substitute that will most adequately replace the usual alloy. Their work is rendered more arduous by the fact that materials such as carbon steel and brass, normally abundantly existent, are now scarce. The scarcity of such basic materials is unbelievable and is a commentary upon the magnitude of the general war effort.

Subzero Temperatures

Subzero temperatures offer a specialized problem in refinery metallurgy from the standpoint of mechanical properties as measured by impact testing. Corrosion is rarely a problem at subzero temperatures.

Nickel-containing steel and alloys are widely used as equipment to operate at subzero temperatures due to the ability of these alloys to maintain a large degree of their room temperature impact values at very low temperatures.

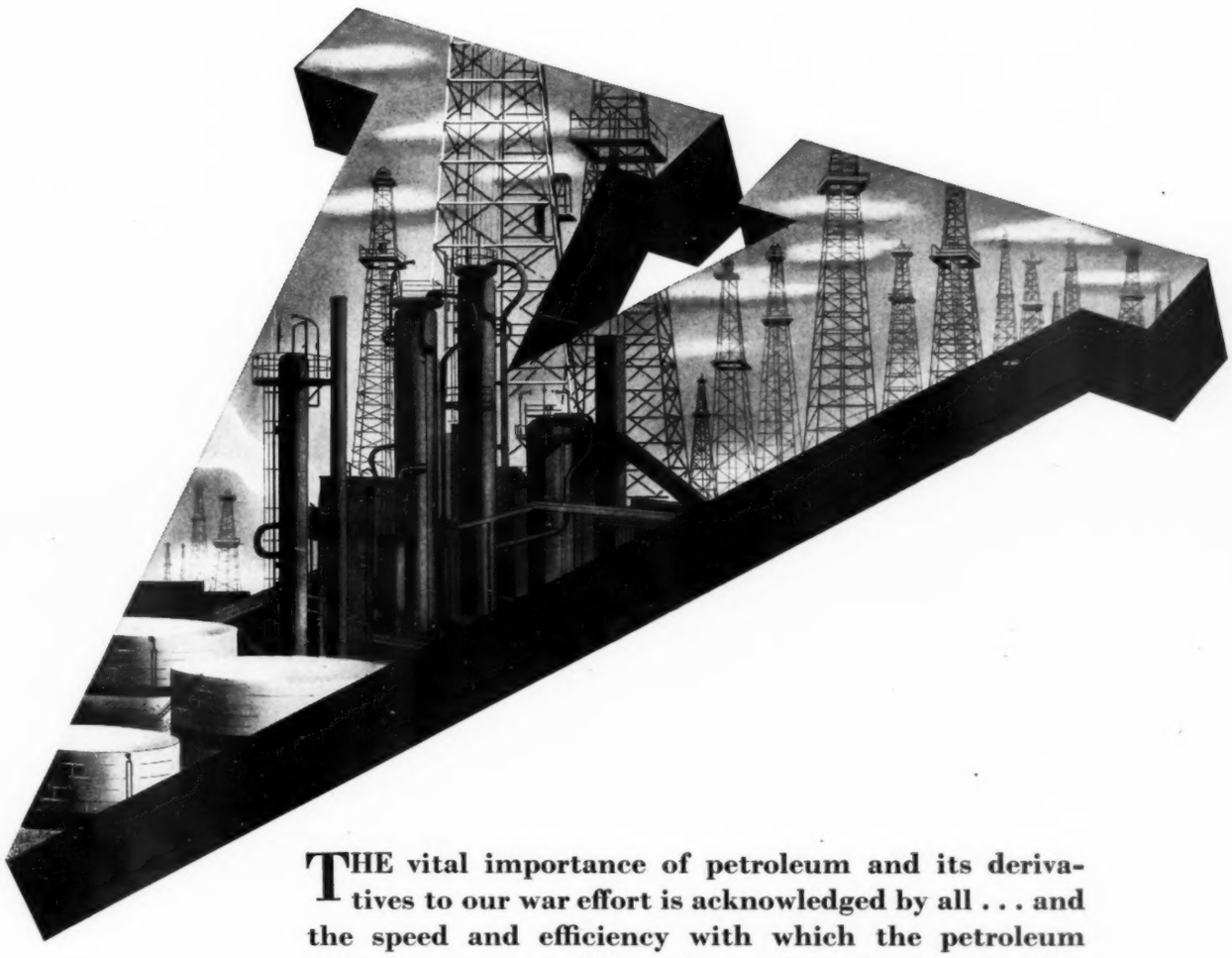
Although no completely adequate substitute exists for the nickel-containing steels for use at subzero temperatures, the carbon steels properly treated with aluminum and controlled as to grain size offer the best substitute at the present time for temperatures down to minus 75°F. Some difficulty may be expected, under present conditions, in obtaining this type of carbon steel.

High Temperature Field

The high temperature region is considered to begin at the temperature at which water first exists in the gaseous state. It will be recognized that corrosion is slight at the beginning of this region and increases progressively with rise of temperature. This is especially

"OIL IS AMMUNITION . . ."

we are helping to keep it flowing



THE vital importance of petroleum and its derivatives to our war effort is acknowledged by all . . . and the speed and efficiency with which the petroleum industry is now producing is a matter of national pride.

With full appreciation of their responsibility as designers and builders of petroleum-handling equipment, Worthington engineers offer their services . . . first, in checking performance of installed units with a view to the continued operation of such equipment at top efficiency . . . and second, for the planning of new equipment for readjustment or expansion of plant facilities.

WORTHINGTON PUMP AND MACHINERY CORPORATION

General Offices: HARRISON, NEW JERSEY

M12-15

WORTHINGTON

true as sulphur is the chief attacking reagent and its vigor of attack is largely controlled by temperature.

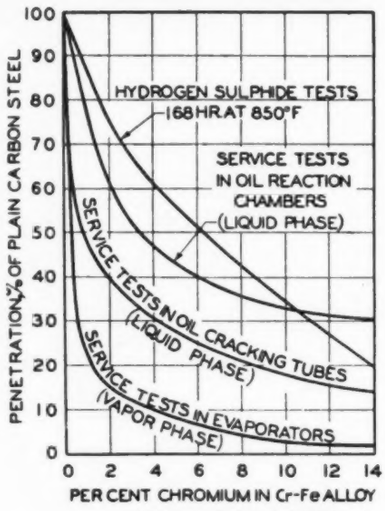
Chromium, as has been previously stated, is the element that must be present to confer on iron resistance to sulphur attack. The order of resistance of the chromium-containing steels is a function of the chromium contents and temperature. Obviously the concentration of sulphur is a factor, as well as apparently the form of the organic sulphur compounds. The effects of chromium in resisting sulphur can be judged from Fig. 1.

Chromium and nickel are important elements in various war materials, hence their conservation is highly desirable. Some steps to conserve these elements are shown in the examples of Table 1.

Alloys, principally of chromium and nickel, are used in refineries at metal temperatures of 1200°F. to 2000°F., often in places in which replacement is most difficult, expensive, and time-consuming.

There is little room within this field for conservation as economics, flue gases, and other considerations have long dictated the 28-25 percent chromium, 11-13 percent nickel type of alloy for tube supports, etc.

The highly alloyed cast-iron "Ni-Resist" could be used up to 1500°F. This alloy contains 15 percent nickel, 6 percent copper, and 2 to 4



(Courtesy Babcock & Wilcox)

Fig. 1. Effects of chromium in retarding sulphur attack

percent chromium, however, and unless the chromium situation becomes much more acute it offers little advantage and possibly some disadvantage due to its inherent low strength and brittleness. Chromium alloys with nickel absent also possess the disadvantage of low strength at high temperature and brittleness after some service.

As the trend in other industry is to the 25 percent chromium, 12 percent nickel alloy, refineries would probably do well to remain with this composition.

Low Temperature Field

The corrosion occurring within the low temperature field, defined here as the region within which liquid water exists, makes a heavy demand on alloys, principally of the non-ferrous type.

A wider range of alloy composition is used within this field than within the high temperature field, as a wider variety of attacking reagents are present. One can expect to deal with sulphuric, hydrochloric, sulphurous, and other acids, and with sodium hydroxide and other bases, as well as corrosive organic compounds and solvents. Sea water and corrosive waters of all descriptions are encountered and present a problem in connection with condensers and coolers.

Against the reagents listed above and others encountered in this field, the non-ferrous alloys, brasses, bronzes, Monel, etc., are widely used. These contain copper with zinc, nickel, tin, and other elements considered scarce at the present time. Lead is used chiefly to resist mineral acids such as sulphuric acid.

Copper is one of the most essential metals in war production, hence curtailment of its use in refinery condensing equipment is necessary in order to allow a greater portion to enter other fields. No truly adequate substitute is available for the tubes of Admiralty and other high copper content alloys now used in connection with condensers and coolers of refineries. Cast-iron, steel, and bi-metal tubes are considered and are being used to reduce the consumption of copper alloys (see Table 2). Perhaps cast-iron pipes and sections offer the greatest possibility as substitutes. The use of the cast-iron equipment requires, as a rule, condenser boxes that in turn places an added demand on the burdened steel industry.

Conclusion

The tremendous demand of the present war production effort has created a shortage of many metals formerly abundantly available for refinery use. The matter of selecting substitutes calls for considerable knowledge and ingenuity upon the part of metallurgical engineers associated with refineries. The daily fluctuation of the abundance or scarcity of materials makes it impossible to offer generally acceptable suggestions regarding substitute materials. In this article some suggestions for substitutes, based on present conditions, are made.

☆ ☆ ☆

TABLE 1

Substitution within the high temperature region

Use	Description				Substitute			
	Percent	Metal	Percent	Metal	Percent	Metal	Percent	Metal
Tubing	25	chromium	20	nickel	18	chromium	8	nickel
	18	chromium	8	nickel	7-9	chromium	1	Molybdenum
	4-6	chromium	0.5	Molybdenum	2¼	chromium	1	Molybdenum
Tower lining	18	chromium	8	nickel	12	chromium	low carbon	
	12	chromium	....	.....	Gunite or steel			
Caps	18	chromium	8	nickel	Cast-iron or enameled steel or iron			
	12	chromium	...	.....	Cast-iron or enameled steel or iron			
Valve trim	18	chromium	8	nickel	12	chromium		
	8	chromium	20	nickel	12	chromium		
Pumps	Use of alloy liners indicated to reduce alloys in blocks and bodies. Not a good spot for substitution.							

TABLE 2

Substitution within the low temperature region

Use	Description	Substitute
Condenser tubes	Admiralty	Cast-iron sections; steel when possible; also Bi-metal tubes.
	70 percent copper—30 percent nickel	Admiralty; cast iron.
	Monel (69 percent nickel—29 percent copper)*	Steel (3 wks. to 4 mos.).
Caps	Monel†	Cast-iron or enameled caps
Vessel lining	Lead, Monel, brass (acid)	Chemical tiles, glass lined or glass equipment.
	Monel	Copper if available. Lead if available.
Pumps	Ni-Resist (15 percent Ni., 6 percent Cu., 2 percent Cr.).	Cast iron.
	Bronze (sea water)	Cast iron.
Pump valves, rods, and shafts	Monel	Brass.

*For use in caustic regenerators.

†Top trays when cold reflux is active; below about 4 trays 12 percent chrome is used, see Table I.

Economics of Water Conditioning For Scale and Corrosion Control

PETROLEUM ENGINEER Exclusive Feature

☆ **Increased operating efficiency, extended life of equipment, and reduced labor and off-stream costs assured by practical cooling water treatment**

by R. C. Rohrdanz
Chemical Engineer

A SIMPLE problem in arithmetic faces the management of every refinery, cycling plant, and natural gasoline plant—the actual dollar cost of complete and thorough protection against water side scale and corrosion as compared to the actual loss in dollars due to impaired condenser efficiency, loss of equipment due to corrosion, and the subsequent losses due to labor and off-stream time when no water conditioning is employed.

We should bear in mind, however, that there are no two problems exactly alike. Certain economies effected in one plant may be much larger or much smaller in the next plant. Likewise, to present and explain each and every factor and detail involved in any one problem would take more time than allotted and would bring in detail that isn't entirely necessary to present the real story of water treating economy. Accordingly, this article attempts to present problems that are entirely representative of those encountered every day in the industry, and at the same time exhibit a fair cross-section of the petroleum processing industry and the extent to which water functions as a primary utility.

R. C. ROHRDANZ

received a B.S. degree in chemical engineering from Kansas State College in 1932—Was chemical engineer for Derby Oil and Refining Company, Wichita, Kansas, 1932-34, and assistant manager of Mid-Continent Quicksilver Corporation 1934-38—Became field engineer with D. W. Haering and Company, Chicago, in April, 1938—From 1939 to 1941 he was on leave of absence from Haering while serving as refinery superintendent for Shelly Refining Company at Bay City, Texas—At the present time he has been granted another leave of absence to care for mining interests in Arkansas.

Water Uses

In all plants devoted to some phase of petroleum processing, natural gas processing, or formation repressuring, water is used for two primary purposes: generation of steam and condensing or cooling, or both, of the process streams. This article cannot cover more than a very few of the problems that affect the economics of petroleum plant operation and, as a matter of choice, will deal mainly with the economics of condenser operation.

The processing units in modern refinery practice that employ water for condensing and cooling purposes include straight-run distillation and fractionating, thermal and catalytic cracking, reforming, hydrogenation, thermal and catalytic polymerization, vapor recovery, stabilization, alkylation, toluene, butadiene, numerous methods of dewaxing, and many others. Although the refining processes are many and varied, the actual condensing and cooling equipment is much the same. This equipment in every case employs either submerged coils, atmospheric coils, tubular heat exchangers, or a combination of these. There are variations in each class of equipment, of course, but when the economics for any particular type of condensing equipment on any particular type of processing unit are worked out, a picture is formed of what happens on any other unit employing the same general type of condensers.

A Cooling Problem

In order to have a problem of definite values assume a crude distillation and fractionating unit is employed. This is the first type of processing ever employed in petroleum refining, and although it has been modernized as refinery engineering has progressed, it is still the basis for nearly all other refinery processes and the crude still units form an important part of every refinery. Assume a unit that fractionates 20,000 bbl. per day of crude oil into its components of naphtha, kerosine, special light fractions, heavier distillates, and reduced crude. Primarily, interest will lie in a light naphtha fraction constituting 20 percent of the crude oil charge. This light naphtha has an initial boiling point of 100°F. and a Reid vapor pressure of 7 lb. The condensing section for this fraction was designed with sufficient area so that 1000 gal. per min. of 85°F. water would condense 330°F. still vapors into a liquid with a 90°F. effluent temperature. As can readily be seen, this condenser must operate at the highest posible efficiency in order to prevent naphtha vapors flashing off in the rundown tanks. This is a condition often found in refineries. The condenser may have been originally designed with a greater margin of safety, but as so often happens, the operators will crowd the rated capacity of the unit, or the characteristics of the crude oil charge may change, or market demands may call for a deeper cut into the crude at times, any or all of which may cause a greater condenser load.

For this entire unit there is a recirculating water system circulating 4000 gal. per min. through the condensers and cooled by a conventional atmospheric cooling tower that under normal average conditions will cool the water to 80° or 85°F. All condensing equipment will be open box, submerged coil type. The water is supplied from a well and is clear and clean with a bicarbonate hardness of 10 grains and a silica content of 1 grain as its principal scale-forming constituents. The refinery is situated on the Texas Gulf

Coast where algae is a serious problem nine months out of every twelve.

Operating Data

The arithmetic problem begins with the unit coming on stream in July with all condenser coils clean and free of scale, oil, and slimes. The unit begins operating with 85°F. water entering the box and naphtha leaving the coils at 90°F. At the end of ten days of operation, the condenser coils have fouled to some extent and the entering water is not always as low as 85°F. due to periods of high humidity common in this climate. Had the coils not fouled, however, the condenser would have kept the average temperature of the naphtha stream down to 90°F. or slightly higher for the period. Instead, the effluent temperature at the end of ten days has risen to 97°F., or only 3°F. below the initial boiling point, resulting in a decrease in yield of one-fourth percent for the ten days. One-fourth percent of the charge is 50 bbl. per day or 500 bbl. for the ten days, which at $1.68 per bbl. amounts to a loss of $840.00.

At this point in the operation, let us assume an auxiliary water pump is brought into use in order to get more water through the naphtha condenser in an effort to keep the temperature from rising higher. This additional supply of water does keep the average temperature for the second ten-day period down to 97°F., but the actual temperature at the end of the period is approximately 100°F. For this second ten-day period then we have a loss of one-fourth percent or another $840.00. The auxiliary water pump requires 10 hp. or a total of 2400 hp-hr. at one-half cent per hp-hr., which amounts to $12.00.

During the third ten-day period the condenser coils have fouled to the point where there is one-half percent loss in yield. This one-half percent amounts to 1000 bbl. or $1680.00 for the ten days. There is also another $12.00 extra power cost for this period.

Downtime Costs

At the end of 30 days operation it is thought advisable to shut the unit down and descale the condenser rather than continue to operate at an increasing loss of yield. A unit of this type should stay on stream from six months to a year without a shut down for routine cleaning and overhauling. Therefore, the shut down at the end of 30 days is entirely chargeable to scale. A minimum period of 24 hours is required for coming off stream, cleaning the condensers, and getting back on stream. Lost production for the 24-hour period amounts to the net profit on 20,000 bbl. of crude. If the net profit on this unit is 10 cents per bbl., we have a loss item of $2000. The labor attendant to the shut down and descaling operation will be at least 50 man hours at 65 cents per hour or a loss item of $32.50.

Summarizing the total net loss for 30 days due to lack of scale control we have:

Total naphtha lost through vaporizing	$3360.00
Total extra power for additional circulating water	24.00
Net profit loss due to 24 hr. shut down	2000.00
Extra labor for 24 hr. shut down	32.50
Total	$5416.50

This loss during the month of July represents one of the five hottest months of the year. The cooler months of winter and early spring will materially increase condenser efficiency due to colder cooling water and tank liquid surface temperatures. In order to keep the annual loss figures on this unit entirely on the safe side, then, multiply the July total loss of $5416.50 by 12 and divide by 3, giving an annual loss of $21,666.00. As the figure given on naphtha losses for July are conservative, as is the net per bbl. daily profit on the unit, this annual loss figure is conservative.

Water Treating

As a means of preventing this loss due to scale, protection can be provided by treating the water with Beta Glucoside on the following basis: With a circulation rate of 4000 gal. per min., assume a 5 percent evaporation loss and a 5 percent loss due to wind drift and blowdown. Taking 10 percent of 4000 we have a make-up of 400 gal. per min. or 576,000 gal. per day. Using 12 p.p.m. of this chemical on the make-up would require 58 lb. per day; 58 lb. per day at $25.00 cwt. is $14.50 per day or $5220.00 per year. Thus, on the basis of scale prevention alone, a net saving would be earned of $16,446.00 for the year for this unit.

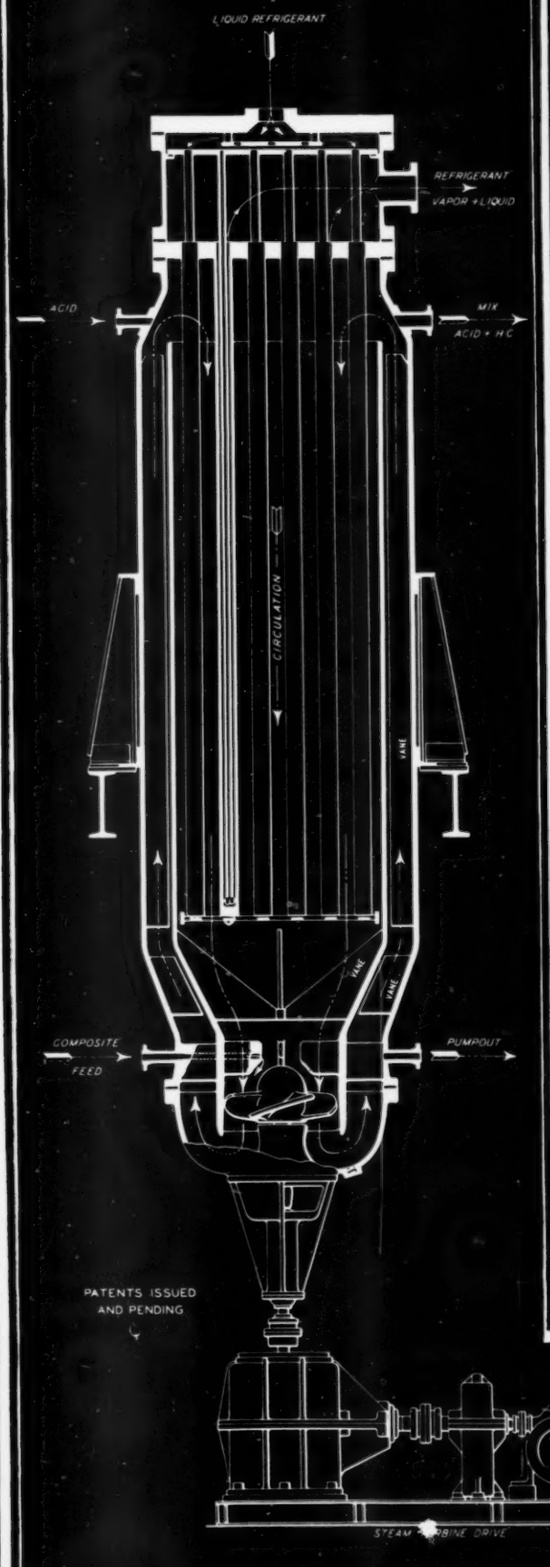
Many modern refineries have vapor recovery systems that are so designed that vapors from rundown and storage tanks are recovered and again processed into liquid products. There is a definite and appreciable expense in processing these vapors through a vapor recovery unit, however, and these processing costs plus subsequent blending costs and losses replace to a large extent the figures used above as "total naphtha lost through vaporizing."

Costs Comparison

The water in cooling systems of this type must, of necessity, contain very appreciable amounts of dissolved oxygen, carbon dioxide, and sometimes hydrogen sulphide that, together with the chloride content, facilitate corrosion due to differential aeration, etc. The fact that the condenser tubes are kept directly free of scale through the use of Beta Glucoside will generalize this corrosion throughout the tube surface area and make it easier to control than if scale were present, setting up concentration cells and in other ways localizing the corrosion, resulting in severe pitting, etc. If the water has a concentration factor of 5, we can treat the make-up with 8 p.p.m. of inhibitor (Quachrom Glucosate), giving a residual of 40 p.p.m. This would require 38 lb. per day at $35.00 cwt., or $13.30 per day, or $4788.00 per year.

It is almost impossible to get an accurate cost of the amount of metal lost through corrosion per year on this kind of equipment. It is likewise difficult to determine down-time loss and labor costs. It is a well-established fact, however, that over any appreciable period of time, the actual losses in dollars due to corrosion on a unit such as this far exceeds the cost of protection by means of an inhibitor. Again for the sake of being completely on the safe side in the present problem, it may be assumed that over a normal five-year period the cost of Quachrom would cancel out the losses in condenser tubing, lines, fittings, and pumping equipment due to corrosion without the protection of an inhibitor. The margin of profit due to adequate corrosion protection would then lie in down time lost production for tube replacement, lost oil due to leaking condensers, and the fire hazard accompanying leaking or questionable strength of tubes. During the present period of war activities when material for industrial equipment is limited, actual facts and figures attest to a saving of several dollars for every dollar spent on an inhibitor. For instance, one refining company found that tubular exchangers could be fitted with steel tubes and protected with an inhibitor and show a $25,000.00 to $35,000.00 annual saving over the use of admiralty or some other high copper alloy. This saving is on one unit alone and had it been necessary to tube with admiralty, actual construction might have been long delayed simply because the copper alloys could not be had on any reasonable terms of delivery.

As previously noted in describing this problem of economics, algae could also be controlled in conjunction with corrosion control by the use of Cupric Chrom Glucosate. If a residual of 100 p.p.m. of this chemical would be sufficient, the make-up water would be treated with 20 p.p.m. This would require 96 lb. per day at $25.00 a cwt., or $24.00 per day or $8640.00 per



STRATCO ALKYLATION CONTACTOR

STRATCO

Alkylation makes possible Higher Yield and Octane than any other method

STRATFORD ENGINEERING CORPORATION

DIERKS BLDG.
KANSAS CITY,
MISSOURI

year for combined corrosion and algae control. This would be approximately the same cost for combined corrosion and algae control carrying 40 p.p.m. residual of Quachrom and using 150 lb. per day of chlorine.

Summarizing Results

Thus, summarizing maximum treating costs for scale, corrosion, and algae control by the methods discussed herein, we have $13,860.00. Balanced against this, we have the figure of $21,666.00 for losses due to scale alone. Conditions exist where this figure could easily be doubled by losses due to corrosion and down time caused by corrosion.

One other consideration is necessary to make a discussion of this particular problem anywhere near complete. On some units such as this, hot condenser streams create a back pressure on fractionating equipment and heater. There is, on every unit, a definite pressure above which cracking will tend to throw the light fractions off color, which to be marketable must usually be above a 25 Saybolt. When this cracking pressure is attained, and additional cooling is not available, then there is only one alternative—reduce the charge rate to the still. An example of the cost of this procedure can quickly be calculated. If the charge on a 20,000 bbl. still is reduced 10 percent, that is equivalent to 2000 bbl. per day. At 10 cents per bbl., net profit, the net loss becomes $200.00 per day or $6000.00 per month, which is almost enough in itself to pay the total treating costs for six months.

Conditioning Investment

Thus, we can readily see what a good investment complete water conditioning amounts to on a refinery unit that is necessary but which operates at a very low net profit per bbl. To get another picture of refining economics as governed by a good or bad water, let us take an actual case of a refiner. This refinery operates an alkylation plant producing 100-octane aviation gasoline. Charge rates, yields, etc., are entirely superfluous in setting up this problem. We simply take the refinery engineer's own statement that this unit earns a net profit of $10,000.00 per day, or putting it the other way around, for every 24 hours this unit is off stream, the refinery loses $10,000.00.

This unit requires about 8000 gal. per min. of water circulated through tubular exchanger type coolers. To assure this unit staying on stream insofar as water side corrosion of condenser tubes is concerned, an inhibitor is used for protection. The daily cost of inhibitor for this and other units on the same cooling system is about $12.00 per day or $4380.00 for a 365 day year. Thus, preventing only 12 hours of down time in one year of 8760 operating hours more than pays for one year's requirement of inhibitor. This is not even considering the cost of tubes for replacement or the saving in cost of steel tubes over admiralty. This brings to light the almost unbelievable returns on the money invested in good water conditioning on some of the processing units in the modern refinery.

These problems could be worked out for every kind of refinery unit employing every kind or type of condenser and in nearly every case a profit will be shown when recirculating cooling systems are employed. We frequently run into once-through cooling systems and recirculating systems that fail to concentrate, however. Here we find the refiner suffering from losses due to scale and corrosion and we find ourselves presenting him with higher costs due to higher dosage rates, and in many cases we cannot show him an advantage; or the cost of treating looks so large to him that he refuses to believe the figures on both sides of the equation. In nearly every case it behooves us to encourage or try to help find a practical and workable way of improving the system.

The Cycling Plant

To make a simple illustration of advantages in a concentrating system, let us assume that on a once-through basis the actual loss due to scale and corrosion is $50.00 per day and the water treating costs are $50.00 per day based on a make-up dosage of 100 p.p.m. If the water system could be improved so that a concentration factor of 2 was possible, then the treating costs would drop to approximately half or $25.00 because only about 50 p.p.m. make-up dosage would be required. Likewise, if the system could be maintained with a concentration factor of 4, the make-up dosage would drop to 25 p.p.m. and the daily cost to $12.00.

Let us leave the refining industry now and go into a plant representing what is currently referred to as the lusty baby of the petroleum industry, the cycling plant. This is a plant that receives natural gas directly from the producing formation, extracts the liquid hydrocarbon content of commercial value, and returns the residue gas to the producing formation.

In a cycling plant, water is used for three main purposes, i.e., steam generation, condensing and cooling of process streams, and engine and compressor jacket cooling. For our particular problem, we will select the recirculating or absorption oil cooler.

The natural gas enters an absorber column toward the bottom and moves upward counter-flow to an absorption oil coming downward. This absorption oil absorbs from the gas the heaviest hydrocarbons present down through the butanes and in some cases a considerable amount of the propane group. The absorption efficiency is governed by the pressure under which the absorber operates and by the temperature of the absorption oil and the temperature of the incoming gas. This absorption oil is almost invariably cooled by atmospheric coils within the cooling tower.

All plants that use natural gas as the raw charging stock are generally similar in type of equipment and processing used and the absorber is common to all of them. Absorbers are operated between 35 and 2000 lb. per sq. in., and may operate on anything from a fairly dry natural gas recovering ½ gal. or less per M. cu. ft. to the richer refinery gases recovering 10 gal. or more per M. cu. ft.

Illustrative Conditions

For this particular problem, we will select a plant processing 30,000,000 cu. ft. of natural gas per day with a recovery of 2½ gal. of liquid products per M. cu. ft. This plant will operate with a 190-lb. absorber pressure, recirculating 28 gal. per min. of absorption oil per M. cu. ft. of gas and effecting about an 85 percent butane extraction. The absorption oil is cooled in atmospheric sections situated within the cooling tower. Condenser surface was so designed that about a 4000 gal. per min. water recirculation rate would cool the absorption oil and process streams. This water has a hardness of 212 p.p.m. due to calcium and magnesium bicarbonate and has a high silica content of 40 p.p.m. It is also corrosive due to 140 p.p.m. of chlorides, 120 p.p.m. of sulphates, high carbon dioxide content, and the usual amount of dissolved oxygen prevalent in cooling tower water.

With an absorption oil temperature of 85°F. entering the absorber, a recovery of 2½ gal. per M. cu. ft. of gas is obtained, or a daily recovery of 75,000 gal. or a monthly recovery of 2,250,000 gal. of butane and natural gasoline or possibly a variety of specialty fractions. We will give this material an arbitrary value of 2 cents per gal. or a gross monthly valuation of $45,000.00. Plant performance indicates that for every 5°F. rise in absorption oil temperature, there will be a 2½ percent drop in absorption efficiency. Therefore, if the cooling coils fouled to the extent that the absorption oil temperatures increased 10° F., the production for the month would be reduced 5 percent, representing 112,500 gal. or $2,250.00 loss.

☆ ☆ ☆

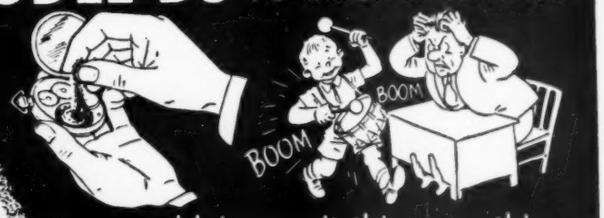
Keep Engines Running

at Maximum Output—with Minimum Trouble

AMERICAN INDUSTRY faces the most crucial test in years. Production facilities are strained to the utmost as governmental and civilian orders pile up. Engines must be at peak efficiency.

Be sure all Diesel, gasoline and gas engines, compressors and pumps are equipped for maximum output, minimum maintenance. Equip each one NOW with Protectomotor Intake Filters. Stop trouble where it frequently starts —in abrasive dust that wears reciprocating parts, causes valves to stick and burn, reducing production as it increases chances for trouble. "Keep 'em flying"—equip with Protectomotors now!

MODEL DS SILENCES, FILTERS AIR TO ENGINE INTAKE



You wouldn't permit this . . . or this . . .

WHY LET UNPROTECTED ENGINE INTAKES DRAW IN DUST . . . CAUSE EXCESSIVE NOISE?

The Model DS Protectomotor is the only device that not only prevents the intake of dust to air-breathing machines, but also silences the intake sound.

Construction is simple, rugged and effective, possessing many exclusive, patented features and special advantages.

A. Series of cylindrical rectifying chambers of scientific diameter to length ratio which smooths out sound waves.
B. Dry Feltex Filtering Medium 99.8% efficient by University of California Laboratory tests.
C. Radial Fin Construction. Permits large area of Filtering medium to occupy smallest possible space.
D. Rigid, galvanized mesh frame.
E. Reinforcing tube. The Model DS Protectomotor is "built like a battleship."

WRITE FOR CATALOG describing filters for engines, pipe lines, ventilation, etc.

STAYNEW FILTER CORP.

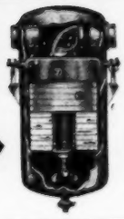
"Air Filter Headquarters"

2 Centre Park, Rochester, N. Y.

PROTECTOMOTOR 99.8 Per Cent EFFICIENT AIR FILTERS

←MODEL D INTAKE FILTER extensively used on intake of engines and compressors where noise elimination is not important. Same construction as Model DS except for silencing features.

NEW→



SLIGHTEST TRACES OF OIL REMOVED FROM AIR TRANSMISSION LINES WITH LATEST PROTECTOMOTOR, MODEL AAPHS PIPE LINE FILTER. Staynew engineers have designed an entirely new type of pipe line filter, now used extensively for the protection of delicate air-powered control devices. This new filter, the Model AAPHS, prevents the passage of the most minute traces of vaporized oil. The AAPHS is actually a "super" filter, used in most applications as the final of two or more stages of filtration. Construction Features: (1) inlet; (2) baffle; (3) Solid Feltex Discs through which all air must pass; (4) carrier tube; (5) outlet; (6) shell; (7) drain cock.

Changing Concepts of Petroleum Lubricants

PETROLEUM ENGINEER Exclusive Feature

☆ Adequacy of conventional specifications for lubricating oils

by J. W. Poole

Manager, Research Division, Lion Oil Refining Company

Foreword

ALTHOUGH it has been long obvious to a few grim realists, the grave inadequacy of our conventional specifications for lubricating oil has but recently begun to receive general recognition.

In retrospect one can find much cause to wonder why from the mid-thirties and before, conceptions about lubricating oils remained essentially static for so many years. During that period, beginning with the development of acid treating, practically all technological developments were merely gestures toward greater conformity to semi-philosophical standards of what a lubricating oil should be. Although the unquestionable purpose of a lubricant is lubrication, performance was not made a direct criterion, but was more or less arbitrarily held to be dependent on certain physical properties of an oil that at best had been very imperfectly shown to be related to performance. Such correlation as did exist between performance and these physical characteristics was based largely on comparison of Pennsylvania oils with oils of the so-called coastal types.

Fortunately for the former it was beneficiary of much the greater amount of processing experience, in addition to being refinable with relative ease to the approximate optimum of its potentialities. Moreover, these potentialities conformed rather well to the lubrication needs of 10 to 20 years ago, when the problems were those related to comparatively low temperatures. Even now oils of this type evidently possess a decided advantage in cold weather driving, when conditions include cold starting and comparatively low operating temperatures with attendant crankcase moisture.

Moreover, other major uses to which heavier petroleum oils were put 20 years ago were pretty much in line with the relative capabilities of highly paraffinic oils. On the other hand the so-called coastal oils' only notable advantages were their low pour points and manifest ability to lubricate Diesels, then rather rare in this country. It is not surprising that we came to generalize to the effect that by and large paraffin base oils were superior, whereas asphalt base oils were inferior. It was also natural to conclude that mixed base Mid-Continent oils were intermediate.

J. W. POOLE

manager of the Research Division of Lion Oil Refining Company, is a 43-year old New Englander, who prepared for M.I.T. at Phillips Exeter Academy—In his studies he specialized in physics, mathematics, and physical chemistry—In research and industry he has devoted himself almost exclusively to petroleum technology and allied fields, and since 1927 has been particularly interested in lubricants and their application—Over a period of about ten years Poole acted in a consulting and advisory capacity for several large organizations associated with the petroleum industry; he has been employed full time in industry for a total of about six years—He first became affiliated with Lion in March, 1939, as assistant refinery manager—Early in 1941 the company undertook a very considerable expansion of research activities, and in the Fall of that year he was appointed to his present position.

Easy as it is to comprehend how those physical characteristics, which roughly denote the degree of paraffinicity, originally came to be accepted as standards of quality, it is less clear why oil technologists and lubrication experts should have been so unresponsive to the changing views and generally progressive attitudes of the 1920's and 1930's when our concepts of and approach to motor fuels became much more realistic and scientific. It may be that until we developed high performance fuels and engines, almost any oil could do a passable job of lubrication except at lower temperatures in which the paraffinic oils held a distinct edge. The older engines not only developed less horsepower for a given cylinder volume, but with their ample non-corrodable bearings provided few corrosion worries.

Both corrosion-sensitive bearings and corrosive substances resulting from higher operating temperatures were still to come. Perhaps necessity was too immature to mother invention.

Nevertheless, increased engine performance does seem to have long antedated a thoroughly realistic and scientific accommodation to its needs. The Diesel engine had become well known for its lubrication difficulties before serious attention was given to drawing specifications on the basis of proved performance. Finally, when, faced with intolerable conditions, a tractor company first insisted that the results of service tests be the prime consideration in choice of lubricant, the reaction of the country's better petroleum technologists and lubrication experts was notable for its lack of concurrence. That outstanding among the early oils to meet these requirements were those very definitely not of the type generally held to be superior was the cause of caustic comment from many a traditionalist. It is a matter of record that oils of what was the so-called naphthenic type, far outperformed allegedly superior oils. To be sure these naphthenics* possessed certain rather spectacular deficiencies, from which the superior oils were relatively exempt, but they did keep engines running more days out of each month, which to a worried engine manufacturer was a fact not to be ignored.

It was in effect disregarded far too long by many of us who should have known better, however. Many oil technologists, including the writer, were so concerned with tricks like solvent extraction to increase paraffinicity that they had little thought or time to give to finding out about improved lubrication. The conventional standards were so deeply entrenched that we

*More properly called aromatics.

gleefully noted how—from such stocks as Mexican and Smackover—we effectively removed the sulphur compounds, which ingredients, in light of more mature knowledge, promise to be the best part of the oil. It is now realized that drastic solvent extraction methods not only remove material properly classifiable as chemical debris, but tend to remove many of those natural additives that act as inhibitors of undesirable reactions and/or impart antiwear properties. But, we learned the "hard way."

Just why it was necessary to learn such basic principles, and why so many still have to be shown by costly experience that only engine performance can be depended upon as a criterion of lubricants, will probably always be somewhat of a mystery. In other branches of petroleum technology, we have long operated on the basis of sound scientific principles, building firmly on a foundation of empirical data. In motor fuel technology the basis has long been one of realism and cold facts, with imaginative thinking scientifically conditioned by and correlated to carefully observed results.

In lubricating oil technology the basis has been a highly philosophical analyses of a few facts, distinguished neither by scope, competence, nor precise observation. Logic based on such insecure ground has been used to establish what a good oil should be; legend, not performance, determined specifications. Research was far more concerned with attempting to find more exact or efficient ways to meet traditional standards than to determine the elements of true excellence.

Lubricating Oil Specifications

The sole purpose of specifications, whether for lubricating oil, structural steel, dried beans, or crushed rock, is to insure quality. Regardless of how expressed, they presumably require that either the quality of the goods shall be as high as science and craftsmanship can make it, or failing this shall be as high as is commensurate with price.

It is elementary that satisfactory specifications must be interpretable in terms of the service the goods are to perform. Whether for use in structures, food, or lubrication, specifications are imposed because the buyer feels that material of such description, and only such material, will give the right kind of service. Many specifications consist of little more than a statement of performance, the buyer relying entirely upon the judgment of the seller. In other forms of specifications, such as those that restrict physical or compositional characteristics, the same requirements are implied, the principal difference being that the buyer places reliance upon his own knowledge or judgment. When specifying strength, crystalline structure, or chromium content the user of the metal believes that it will support the necessary loads and resist the action of such corrosive substances as presumably will be present.

Similarly, when buying oil for his trucks he describes an oil that he believes will keep his engine in the best possible condition for the greatest possible time. Except as they may assure the attainment of this end, the specifications on which he buys his lubricants can have no meaning.

So far it has not been possible to provide such assurance on the basis of laboratory determinations of physical characteristics.

Nevertheless the consumer of lubricants has been firmly indoctrinated with the idea that certain physical characteristics of lubricating oils plus information regarding the source of the lubricant can be used to predict

Reduce your Valve Maintenance Costs with

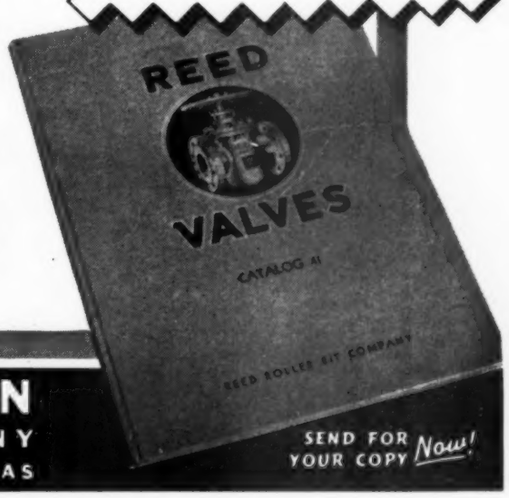
LOWER PIPING UPKEEP COSTS

Lower piping upkeep costs are mainly dependent upon the correct selection of valves for the services in which they are to be used, and the reputation that valve maintains for dependable service and low maintenance costs.

Reed Valves are correctly designed for economy of operation in any service and their self cleaning, easy operating characteristics are not to be found in any other valve on the market.

Quarter-turn operation . . . lifting and cleaning action of the moving disc . . . through conduit . . . non-rising stem . . . appropriate materials . . . combine to assure clean seats of corrosion resistant material, positive closure and easy, trouble-free operation.

REED VALVES



REED VALVE DIVISION
of the REED ROLLER BIT COMPANY
P. O. BOX 2119 HOUSTON, TEXAS

SEND FOR YOUR COPY Now!

service performance.[1,2] Even assuming that some such criteria can or could be developed, the connection between them and performance is not self evident, and remains to be established. Certainly it is not obvious that gravity, viscosity, flash, fire, color, carbon residue, pour, neutralization number, etc., can be interpreted directly in terms of engine deposits, bearing wear and corrosion, ring sticking, piston crown scuffing, and other elements that are manifest factors in maintenance costs, and before one set of standards can rationally be used for evaluation of the other, the essential identity of the two must be established. A prerequisite is accumulation of enormous amounts of carefully recorded data.

Such a correlation has been accomplished when a specific characteristic or combination of characteristics has been shown repeatedly and invariably to produce a specific result. We may then justifiably consider that specification of characteristics or combination thereof is equivalent to specifying a result; and if the former is determinable with relative ease, its value as a specification is obvious. For example, if a Conradson carbon test, requiring about an hour, could tell us how heavy would be the engine deposits after 15,000 miles of operation, the necessity of a laborious and expensive direct determination would be eliminated. If the viscosity index or some accelerated oxidation test firmly correlated with the tendency of an oil to form deleterious service derivatives another simplification could be enjoyed, and if flash point was found invariably to be quantitatively associated with oil consumption, still more time, expense, and worry might be saved.

Regrettably, no notable correlations have ever been established between these or any other simple laboratory tests and service performance. Even the best approximations thereto are so subject to exceptions that complete reliance is impossible. The best indicate only probabilities. The most that can be accomplished by purchasing on today's conventional specifications is to improve somewhat the odds of getting a "reasonably satisfactory" oil; the chances that the oil will be an extremely bad choice cannot thus be eliminated, merely somewhat reduced. If the best oil is obtained it will be either by pure chance or because greater emphasis is placed on service data than on conventional criteria.

The Standard Tests

Although possibly everyone sufficiently interested in the subject to read this article is reasonably familiar with the A.S.T.M. standard tests for lubricants, a brief review of their significance may lead to a greater appreciation of how they should and should not be used. Except for a few used occasionally or only on certain specialty oils, the following covers all the A.T.S.M. standard tests plus certain unofficial criteria, more or less widely believed to be indicative of specific propensities of lubricants.

Depending on the anticipated use, personal opinion, custom, etc., certain of these properties are evaluated by two or more alternate procedures. For example, viscosities are determined at various temperatures and several forms of apparatus; oxidation by Sligh, the several manifestations of the Indiana procedure, and others. There are also several emulsion tests, the more common being the well known Demulsibility and Steam Emulsion tests.

Commonly, tests are made for and oils judged by:

1. Gravity
2. Flash
3. Fire
4. Viscosity
5. Viscosity index
6. Pour
7. Color
8. Neutralization number
9. Conradson Carbon
10. Unsulfonated residue
11. Corrosion
12. Sulphur
13. Oxidation tests
14. Emulsion tests

All but a minor part of petroleum lubricants are still sold on the basis of these tests, there being a persistent belief that either in themselves or collectively they denote, at least qualitatively, something that will happen to, or because of, the oil in actual service.

Moreover, much data can and will be produced in support of these beliefs, and, unquestionably, a highly expert and experienced analyst can deduce many significant and highly probable happenings by their interpretation in light of his empirical knowledge. Nearly all are invaluable in process control, for these tests are sensitive to variations in the nature of the product, when and if the raw material source remains substantially uniform. It is in fact difficult to visualize how these tests could be improved upon for control purposes, except possibly in minor detail. Coupled with the simplicity and rapidity of the procedures, they possess utility of which control laboratories will doubtless avail themselves indefinitely.

For instance, variations in gravity, flash, fire, viscosity, and Conradson Carbon, either severally or individually, are indications of the nature and approximate degree of altered conditions in fractionating equipment. Likewise, many of their relationships (between gravity, viscosity, viscosity index, flash, fire, and several others) can provide pertinent information relative to happenings in an extraction plant. Color determinations can be made in a few seconds, yet judiciously interpreted, color is a highly sensitive control standard for many steps used in lubricating oil refining.

Pour is of obvious significance in dewaxing operations. All in all, the writer would ask for no better analytical tools to effect the practical purposes of technology. Nor would he hesitate to rely on them for selection of the more promising avenues of research, wherein prophecies based on them will be subject to confirmation or proof of fallacy by less fallible and basically meanful evidence. In fact, so long as use of these tests is confined to competent technologists who are aware of their limitations they can be invaluable.

On the other hand, their very utility, when kept in their proper place, may have been instrumental in bringing about dangerous reliance outside their proper scope. Actually, after lubricants have become mere articles of commerce and can no longer be viewed in light of their technological history, these tests are reliable indications of few facts that have more than academic significance.[3,4,5]

To the commercial distributor of lubricants and his clientele, it is of small moment to look at a set of A.S.T.M. tests and conclude that the gravity, flash, viscosities, and carbon residue prove rather conclusively that this is a Pennsylvania oil or possibly a solvent extracted Mid-Continent oil. To be sure such interesting and academic probabilities can be deduced; in many cases there will be sufficient clues to reconstruct almost everything that has happened to the oil. What they will not show is the obscure "little" differences between oils that apparently determine for which specific uses an oil is superior, average, or actively undesirable. Not in that entire list can be found evidence of whether or not the oil will leave serious engine deposits or be corrosive. The extent of their unquestionable significance is confined to a few minutiae on which the consumer has been oversold by false emphasis, but which in fact rarely possess any material significance to the average user. To the best of the writer's belief, the following is a fair statement of what each item of the preceding list of conventional specifications signifies.

Gravity

Gravity: As this quality is a function of several variables, including both

volatility and chemical constitution, it is by itself practically without meaning. When considered jointly with viscosity, flash, and/or fire, it provides a rough index of the chemical constitution of the major volumetric portion of the oil. On an approximate basis it serves to classify an oil as paraffinic, naphthenic, or aromatic, which, according to popular belief, are terms synonymous respectively with good, bad, or worse.

Flash and Fire

Flash and fire, like others of the standard tests, are significant in connection with plant control. From the consumer's viewpoint they are considered, with some evidence of validity,[6,7] to be indicative of consumption in hot ventilated lubrication such as the cylinder walls and pistons of internal-combustion engines or compressors.

These properties are partial indices of volatility and also of tendency to evaporate at temperatures encountered. The writer is unfamiliar with any precise correlation between flash and fire and oil consumption although there is much evidence that a relationship does exist.[6,7] One thing does appear evident: the variation of flash and fire between well fractionated oils of the same viscosity but of different source can only be a minor factor in the cost of lubrication. There is in fact some amount of data interpretable as evidence that the amount of consumption due to a moderate vaporizing tendency of oils is desirable from the viewpoint of maintaining cleaner engine parts.

The theory that compressor lubricants of low flash and fire are unduly hazardous seems logical but cannot be considered as definitely established, and in view of the air-oil ratios to be found in compressor cylinders, appears very doubtful.

As is the case with the majority of conventional standards, there is a possibility that by painstaking observation flash and fire might be correlated with performance to provide much more definite and reliable information than they do at present. Doubtless much of the significance at present attributed to them is factual, possibly more is wholly or partially untrue. All of it is so contaminated by lack of adequate confirmation that complete reliance can be placed on little or none.

Viscosity

One of the few things we seem to know about viscosity is that, other things being equal, heavy-bodied oil will support a greater load and seal a bigger hole than will an oil of lower viscosity. We also can accept as reasonably well proved that oils of higher viscosity will rob a system of more horsepower, notably at high speeds, than will thinner oils.[8] Furthermore, we know that an oil that is extremely viscous at low temperature can cause very bothersome starting troubles.[9,10] In fact, we know so much about viscosity, often in a contradictory sense, that it can well be wondered whether our knowledge is of much use; possibly it is fully as confusing as enlightening.[11] Certainly, we cannot with assurance determine the proper SAE grade for many uses except by service performance any more than we can determine generally by conventional standards what oil is best for a specific duty.[12]

Viscosity Index

Viscosity index is an indication of how greatly the viscosity of an oil will change with temperature change. Much has been written and spoken showing the logical importance of this property.[13] On the other hand, purely factual evidence seems a bit scarce, although in unconvincing amount and scope it exists as a matter of record.

Even the facts seem to have become inflated with logic, such as the deduction that the way to obtain adequately low starting viscosities and maintain a sufficiently high operating viscosity is to raise the viscosity index.[14]. The writer is familiar with some excellent work to establish the "maximum permissible viscosity for easy starting," but has yet to see it associated with a careful determination of the lowest permissible operating viscosity. There is little reason to believe that at least most of the equipment requiring a low viscosity oil for starting will not be satisfactorily served, as far as viscosity can serve, at any operating temperature likely to be encountered in the same locality and same season just as well by a 70 viscosity index, a 50 viscosity index, or even a zero viscosity index as by one of 110 viscosity index.[15,16]

Well, perhaps our artist did take us too literally — even 420 Lining won't make braking *that* easy. But it is a proved fact that drilling is a lot simpler when the rig is equipped with J-M 420.

At least, that's what many operators in the field report. They say it's due to the fact that J-M 420 Rotary Lining provides such unusually even feed-off and easy load control. Rim scoring is minimized, too. And J-M 420 keeps on delivering these advantages, for it's tough and durable, hard to wear out.

That's why most manufacturers of drilling rigs use J-M 420 as original equipment. For details, write for brochure FM-10A. Johns-Manville, 22 E. 40th St., New York, N. Y.

Johns-Manville 420 ROTARY LINING

As a matter of fact, viscosity index has been given relatively little direct consideration as an indication of viscosity-temperature susceptibility. In the writer's experience the emphasis has nearly always been placed upon it as a secondary standard of paraffinicity.

Pour

Pour, contrary to popular belief, is far from a reliable indicator of the lowest temperature at which an oil will flow and/or reach the areas to be lubricated. A new criterion of this obviously important consideration is needed. Pour does provide useful information relative to storage and manufacturing control of an oil; but as a service guide it is merely indicative of a temperature that is indefinitely greater than that at which the oil will retain mobility.[17]

Color

Any significance the user of an oil can attribute to color is so hedged about by conditions and qualifications as to render it absolutely without meaning as a specification. Its value is limited exclusively to those concerned with technology. As fluorescence can be imparted at will, it too is devoid of meaning.

Neutralization Number

Neutralization number is a subject that could be discussed at great length. From the technologist's viewpoint it is very useful. From the user's—and when referring to fresh oil—it can be dismissed on the grounds that established manufacturers of lubricants simply do not market oils of initially excessive acidity.

Its significance lies in the increase in acidity in service. Although the subject is too extensive for general discussion here, it is well to note that a rapid and continued increase of neutralization number has been shown to be related to unsatisfactory performance.[18] Nevertheless it is a secondary rather than a direct criterion;[19] a tool probably best reserved for technology and research. It would seem that its practical corollaries could be most surely and best served by blanket specifications stated directly in terms of service.

Carbon Residue

Carbon residue (Conradson Carbon) belongs in a category that inherently warrants suspicion. The procedure appears to have been derived primarily from logic rather than experimental correlation with facts. As has proved true with other conventional standards, experience has shown that carbon residue can be usefully employed in petroleum technology. Likewise shown is the falsity of the popular concept that this property is a suitable means for predicting engine deposits.[20 to 26] It can be argued that it is a factor in such deposits but it definitely is not a controlling factor. Oils with relatively high carbon content can give very clean operation, others with much lower values can cause very serious carbon and lacquer troubles, referring of course to the values obtained on the fresh oil.

In practice the production and deposition of carbon is a highly complicated procedure compared to the rapid laboratory method. In fact, mere presence of carbon-forming material does not mean that deposition will ensue. For example, highly detergent oils can show large carbon residue values and still leave the engine clean. It is not desirable to discriminate against a low carbon residue oil, which may possess virtues not apparent from its superficial characteristics.[27, 28, 29]

Unsulfonated Residue

Unsulfonated residue, as a research tool, gives a semi-quantitative indication of paraffinicity. It is not an indication of stability in the practical sense: White oils meeting unsulfonated residue requirements by a large margin usually stand up poorly in service. As it is only rarely used in lubricant specifications, it has only a minor bearing on the present subject.

Corrosion

Certainly in its present form the common copper strip test for corrosion is of little value. To be sure some oils that show positive are corrosive, but some of the very best oils from the corrosion viewpoint also show positive; and many highly corrosive oils show an unquestionable negative. In fact, the writer has seen negative, but corrosive, oils changed by the use of inhibitors to positive but non-corrosive oils.

In view of such a situation the true value of this highly regarded test would appear to be conservatively stated as questionable.[30]

Sulphur Content

Specification of maximum sulphur content, without specification of the form wherein such sulphur exists, represents about as arbitrary and useless a specification as can be conceived.

By far the greater portion, and probably all, the sulphur that can survive the more usual procedures of petroleum lubricant refining appears to be not only harmless but extremely beneficial. The literature is replete with confirmatory matter on this point. Patents covering the use of sulphur compounds as agents to promote oiliness, film strength, stability, etc., are numbered by the hundreds.[31, 32]

The widely believed legend that sulphur in an oil denotes corrosiveness is absolutely lacking in foundation.[33, 34] The fallacy doubtless arises from knowledge that certain familiar forms of sulphur, rarely if ever present in properly refined petroleum lubricants, are corrosive to various metals. Known corrosive forms include elementary sulphur, sulphuric, and sulphurous acids, their anhydrides, and a few others.

It is of interest to note that work carried out by some of our outstanding students of fuels and lubricants has shown that sulphur "contamination" of lubricating oil by a high sulphur motor fuel can very effectively reduce bearing corrosion.[35]

Oxidation Tests

The inadequacy of existing oxidation tests is well recognized by nearly all competent authorities.[36, 37, 38] Unquestionably they can be used to obtain useful information, but their scope is so greatly restricted that they, like others of the conventional tests, should be relegated to purposes of research and control in the hands of those familiar with them.[39] Like the copper strip test they have been found to give a poorer rating to an oil after it has been improved; being notable for a tendency to show as "undesirable," additives that are highly useful as oxidation inhibitors.

We badly need a reliable oxidation standard. In view of the present attention being given the matter, its advent may not be far distant.

Emulsion Tests

Emulsion tests: The writer must confess to inadequate knowledge pertaining to the proved relationships between these widely specified tests and performance in actual service. Evidently users of turbine oils find them useful tools; logically there could be a connection—as some believe—between them and the propensity of a motor oil to form cold weather emulsions; but logic, as repeatedly stressed herein, is forgetful of factors that are extremely important, and it can be imagined that conditions in the scrupulously clean laboratory vessels used to test clean fresh oil might deviate very materially from an automobile crankcase. The writer is definitely skeptical of the general utility of emulsion specifications and, moreover, has found the opinions of those he has consulted to be distinctly hazy on this point.

Plantation Pipe Line Pumping Stations Feature Automatic Control

☆ Only one operator required for each shift as result of new control system—Marks first application of series pumping on line of such large capacity

PUMPING stations on the Plantation Pipe Line, longest line ever laid for transportation of refined petroleum products, are of modern architectural design, each being divided into a pump room, control room, and tool room. The manifold platform, an important part of the layout, is outside the pumping station proper. A glass partition separates the control room and the pump room; all other rooms are separated by solid partitions.

Automatic Control

An important feature of the stations on the line is the system of automatic control. The entire operation of the pumping station may be started or stopped by means of electric controls operated from the control desk, which is situated in a control room elevated 3 ft. above the level of the pump room floor and from which a complete view of the pump room may be had. The system installed marks a new high in automatic control of pumping stations and is the result of engineering developments accomplished by joint effort of Plantation engineers and engineering staffs of equipment manufacturers.

To describe in detail the method of control: on the control desk each control valve throughout the station is indicated by a green light and a red light. When the light is green the valve is closed; when red the valve is open. All control valves are motor-operated. When the station is shut down and it is desired to resume operation, the operator pushes the start button for the No. 1 pump. Without further control there follows in sequence these operations: (1) the suction valve on pump opens; (2) vent valve on pump case opens to clear vapors from the pump; (3) pump motor starts and comes up to speed, and (4) valve on pump discharge line is opened, placing unit on the line; vent valve closes simultaneously.

Starting of the No. 2 pump is effected in the same manner.

When it is desired to shut the station down stop buttons are pushed and the reverse sequence occurs.

Failure of the mechanism to function at any point is indicated immediately by the red and green lights on the desk.

Series Pumping

Pumping equipment is somewhat unusual and, according to Plantation engineers, this is the first application of series pumping on a line of such large capacity. Each station has two specially designed centrifugal pumps arranged in series. On the 12-in. section of the main line the pumps are direct-driven at a speed of 3600 r.p.m. by 600-hp. explosion-proof motors, the most powerful of this type ever built. On the 10-in. section of the main line pumps are driven at the same speed by 450-hp. explosion-proof motors. As all motors, switch gear, and controls are explosion-proof, no firewalls are required in the pumping stations. Castings for all motors are identical, thus only two standby motors are necessary along the entire 788 miles of the main line. All electric power is taken from public utility lines.

Dispatching

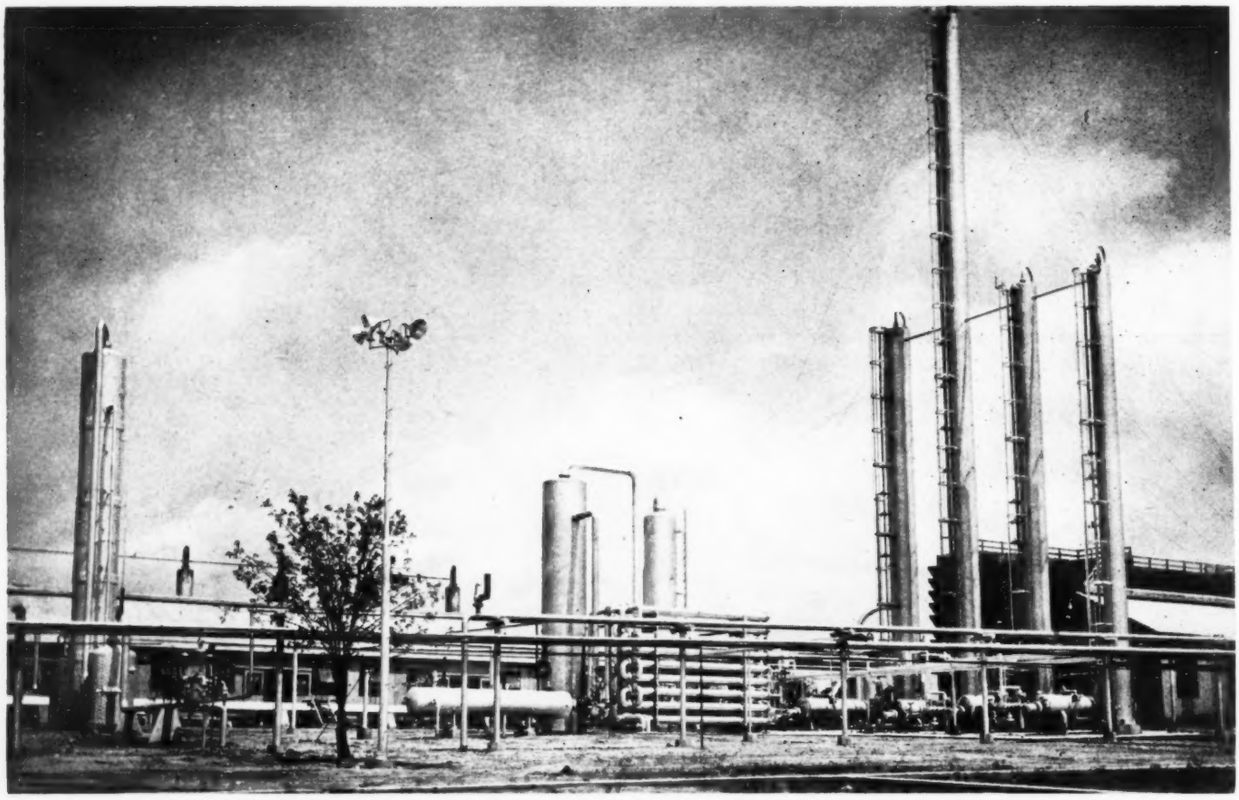
Pumping stations are connected by direct teletype over a leased circuit. By means of the teletype the consignee is advised when a tender enters the line and when it may be expected to arrive at its destination. Recording gravitometers, accurate to within 0.022 deg. by weight, are installed on the line at each pumping station and terminal. This equipment records constantly the specific gravity of the product being pumped, and as a change in specific gravity indicates a change in product, it can readily be determined when receipt of a tender has been completed and the flow should be switched into another tank. Volume delivered is determined by use of accurately calibrated volume meters. Accurate and careful handling of the product is thus assured, and "heart" cuts can be taken from the line with no chance of error.

Use of the gravitometer obviates the need for water slugs to separate the various products pumped through the line, such as gasoline, kerosine, etc. This has beneficial results. Water haze in kerosine is thus eliminated; contamination and slop also are reduced.

Stations are being operated at a 50 lb. per sq. in. suction pressure and a 900 lb. per sq. in. discharge pressure.

As designed, the stations can and are being manned by one operator for each 8-hour shift. In addition to a crew of operators sufficient for 24-hour a day pumping, a chief engineer resides at each station.

☆ ☆ ☆



WARREN PETROLEUM CORPORATION
CUMBERLAND, OKLAHOMA

ANOTHER REPEAT PRECEDED BY:

GALVA, KANSAS, 1936

ARANSAS PASS, TEXAS, 1938

FAIRBANKS, TEXAS, 1939

GRIFFIN, INDIANA, 1942

Engineered, Designed and Constructed by

GASOLINE PLANT CONSTRUCTION CORPORATION

713 Second National Bank Building

HOUSTON, TEXAS

F. W. DYE
Continental Building
DALLAS, TEXAS

M. H. KOTZEBUE
O. L. OLSEN

B. A. PADON
424 North Boulder
TULSA, OKLAHOMA

P 772.
P 774.

Showing the neat arrangement of the compressor header

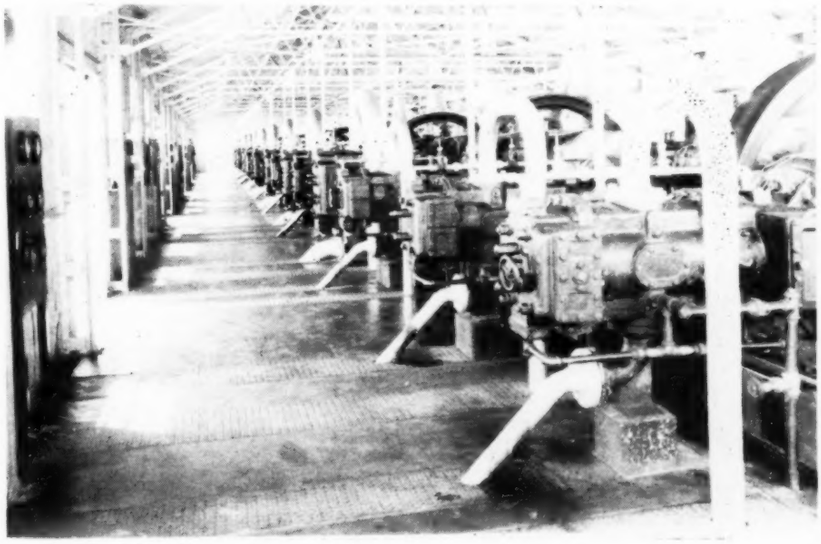
PETROLEUM ENGINEER Exclusive Feature

Compressor-Absorption Type Gasoline Plant Produces Four Products

☆ **Natural gasoline, normal butane, *iso*butane, and propane manufactured by new Oklahoma installation—Two-stage compression utilized**

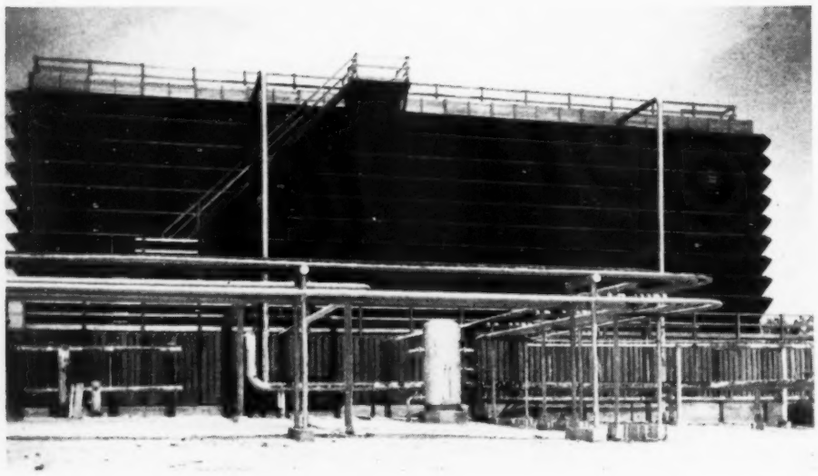
by Frank H. Love
Managing Editor

MANUFACTURING four products, natural gasoline, normal butane, *iso*butane, and propane, Warren Petroleum Corporation's compressor-absorption gasoline plant in the Cumberland field, Oklahoma, is now in operation. This is one of the several plants given high priority rating by the government last fall because of the need for *iso*butane, a product essential in the manufacture of 100-octane aviation gasoline. Despite this high priority rating, however, the scarcity of materials prompted the salvaging and rebuilding of certain used equipment available from other of the company's properties. Such equipment was installed in instances where it was felt the war effort would be aided, either by releasing for other purposes new equipment that would be required or by preventing delayed construction of this plant. For the most part, however, equipment throughout the plant is new and is typical of the most modern in gasoline plant usage.



Interior of compressor building

The Cumberland field is entirely an oil-producing area. Casinghead gas from the 45 wells connected to the plant is trapped off the well separators at atmospheric pressure and brought to the plant under 3 to 5 in. of vacuum, being transported to the plant through an 18-in. main line three-fourths mile



Atmospheric-type cooling tower with 15 bays

in length. The plant is situated that distance from the field and on high ground due to the fact that when the Denison Dam project is completed the entire Cumberland field will be under water. Laterals from the main line to the wells vary in size from 14 in. down to 6 in.

Processing Cycle

Arriving at the plant the gas is passed through an inlet scrubber prior to entering the first-stage of compression, where it is compressed from the plant intake pressure to 40 lb. A small amount of gasoline is recovered in this stage of compression and is charged directly to the dephlegmator in the absorption system. The temperature of the gas when leaving the first-stage compressors is approximately 150°F. and is reduced to atmospheric temperature before going to the second or high stage of compression where the pressure is increased from 40 lb. to 300 lb. The temperature of the gas leaving these compressors is about 200°F., and is reduced to atmospheric, or approximately 75°F., by the second-stage gas coolers situated in the base of the cooling tower. The compressors are 200-hp. horizontal units. There are nine 17-in. low-stage compressor cylinders, ten 8-in. high-stage compressor cylinders, and one 7-in. cylinder for recompressing.

One-half, or slightly more, of the plant's total gasoline production is removed from the gas stream by high-stage compression and this product is charged directly to the de-ethanizer, which is operated at a pressure of 350 lb. and a temperature of 250°F. Ethane is taken from the top of this tower into the residue system. The bottoms go to the depropanizer, which is operated at a pressure of 230 lb. and a temperature of 262°F. The top product, propane, after being dehydrated, is sent to storage, then transferred to a loading rack and into tank cars for shipping. A limited amount of the propane, however, is blended with normal butane for the purpose of serving rural users of this liquefied petroleum gas who do not have natural gas available. Because the gas is slightly sour, bottoms from the depropanizer are treated before being passed to the debutanizer. The treaters are operated at a pressure of 130 lb. and at a temperature of 120°F. The bottom product of this tower is natural gasoline. The top products are butane and *iso*butane, which go to the de*iso*butanizer, operated at a pressure of 85 lb. and a bottom temperature of 140°F. *Iso*butane is taken from the top of the tower and normal butane from the bottom, both products being sent to storage. Between each of these columns, of course, the products are cooled.

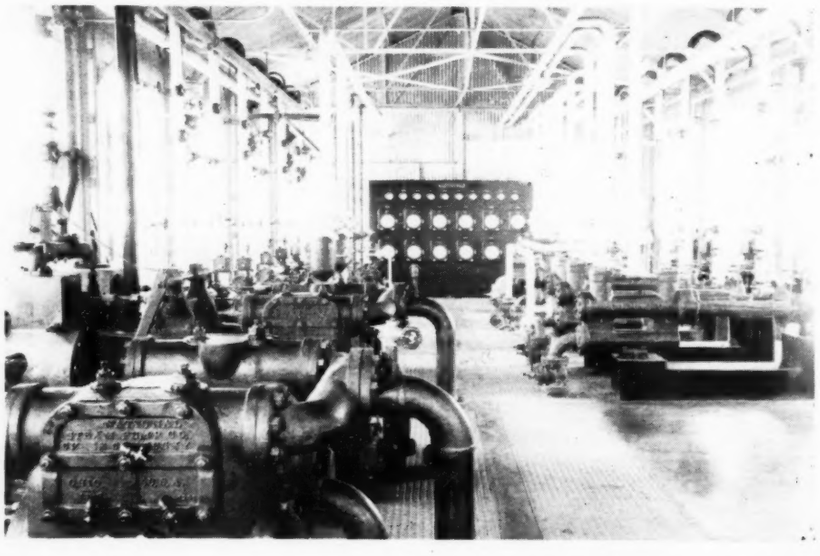
A departure has been made in the method of charging the several fractionating columns, in that the product is transferred from one to the other by pressure rather than pumped. To accomplish this, static pressure liquid controllers are installed on all tower reflux tanks to control the pressure on the columns. The one exception is the de-ethanizer column where a back-pressure valve has been installed to serve the same purpose. To operate such a system the product must be pure so that the reflux tanks can "run full."

After the gas from the high-stage compressors has been cooled from 200°F. to 75°F., it passes through a scrubber and into the absorber, which is operated at a pressure of 300 lb. Lean oil is charged to this absorber at a rate of 150 gal. per min. by a 16 by 6⅝ by 14 reciprocating duplex steam-driven pump.

Rich oil from the absorber passes to a vent tank and then the vapors are vented into the suction of the high-stage compressors. Rich oil is discharged from the vent tank through heat exchangers to the still. Vapors from the still run to the dephlegmator, then through primary and final condensers, the product discharging into the raw make tank operated at 50-lb. pressure. The contents of this tank are charged to the de-ethanizer column. Vapors from the raw make tank are passed to the recompressor and the gasoline removed there at a pressure of 300 lb. is charged to the de-ethanizer, whereas vapors off the recompressor accumulator are passed to the absorber.

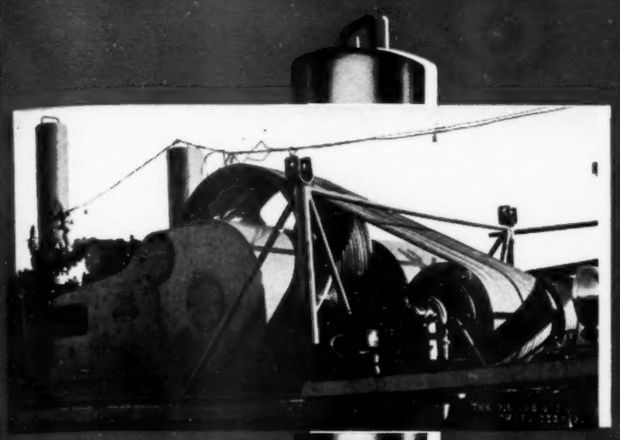
Product Storage

Product storage consists of four tanks having a capacity of 24,000 gal. each for natural gasoline; two tanks of



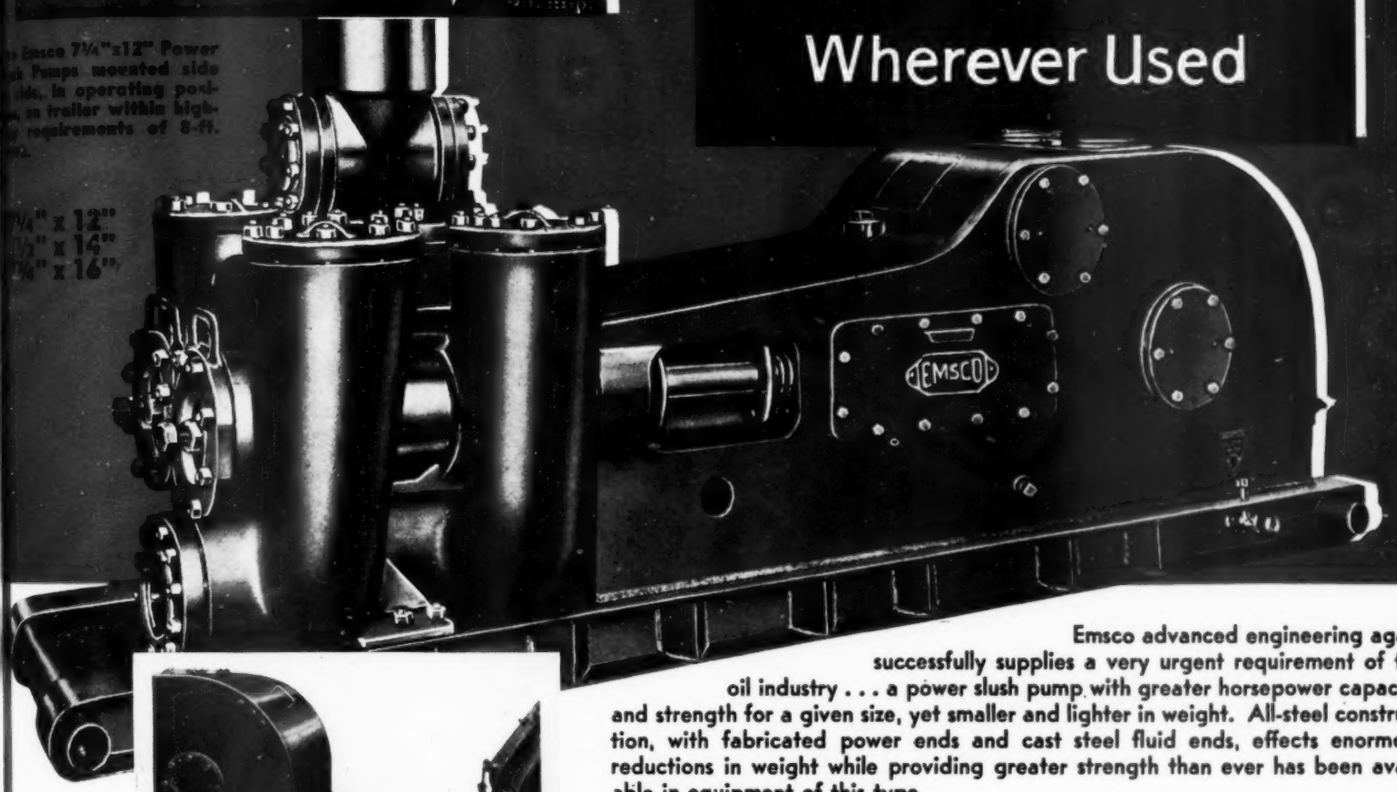
Interior of pump house. Control panel in background

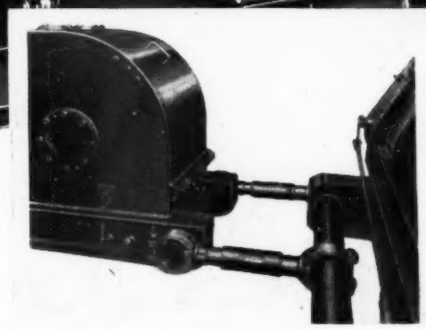
They're Setting New Standards of PERFORMANCE *Wherever Used*



Emsco 7¼"x12" Power Pumps mounted side by side, in operating position, on trailer within highway requirements of 8-ft. width.

7¼" x 12"
7½" x 14"
7¾" x 16"





EMSCO ADJUSTABLE POWER PUMP SPACERS keep pumps in perfect alignment, and enable maintaining correct v-belt tightness. They pay for themselves in better performance and less operating difficulties.

Emsco advanced engineering again successfully supplies a very urgent requirement of the oil industry . . . a power slush pump with greater horsepower capacity and strength for a given size, yet smaller and lighter in weight. All-steel construction, with fabricated power ends and cast steel fluid ends, effects enormous reductions in weight while providing greater strength than ever has been available in equipment of this type.

The 7¼" x 12" size is the only pump of comparable bore, stroke and horsepower that can be mounted side by side on a trailer, in operating position, within highway reqirements of 8-ft. in width. They are sufficiently light to be mounted on a gooseneck trailer.

All sizes are completely roller bearing equipped, including wrist pin and eccentric bearings. Renewable crosshead guides in frame, with needle-type roller bearings in crosshead. Wide faced herringbone gears of heat-treated alloy steel; fluid liners exposed to view; complete automatic circulating oil bath throughout.

These and other exclusive features are responsible for the power-plus capacity, the flexibility, and economical performance of Emsco pumps wherever used.

EMSCO DERRICK & EQUIPMENT COMPANY

Plants: Houston Los Angeles Dallas

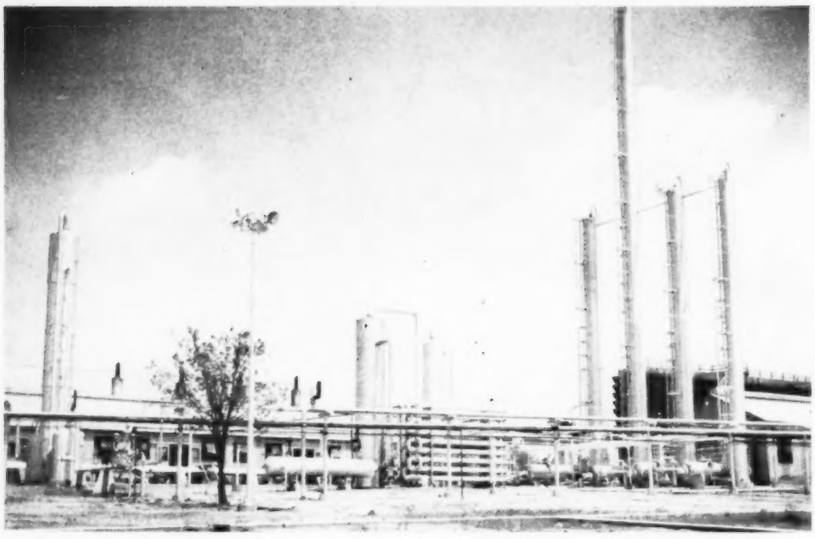
Less Weight and ater Horsepower Capacity

EMSCO

REG. U. S. PAT. OFF.

Plus The Strength and Ruggedness of Steel

POWER SLUSH PUMPS



General view of the processing area

the same capacity for normal butane; two tanks each having a capacity of 12,000 gal. for *iso*butane, and two 12,000-gal. tanks for propane. These products are pumped 4½ miles to the loading rack through one 4-in. and one 2-in. line. For pumping the liquefied petroleum gases two 8 by 12 close-clearance steam-driven pumps are used. Natural gasoline is pumped by a 10 by 4½ by 10 steam-driven duplex pump.

Water System

Two water wells 250 ft. deep provide the plant with a soft water of only 1½ grains hardness. The water is lifted by two 8-in. deepwell turbine-type pumps driven by 10-hp. motors, each having a capacity of 100 gal. per min. Discharge is into two 750-bbl. tanks. Overflow from these tanks is into the base of the cooling tower. A line from the tanks connects with a 250-gal. boiler feedwater tank. A connection is also made to this line to provide make-up water to the jacket-water cooling system. The latter system, incidentally, is closed, water being circulated by a 5-in. centrifugal pump driven by a 20-hp. motor.

Steam System

Four 125-hp. oilfield-type boilers, operating at a pressure of 300 lb., provide steam. Condensed steam is utilized as much as is possible, very little make-up water being required. Low-pressure condensate from the distillation unit and from reboilers of the several fractionating towers dumps into the low-pressure condensate tank. This is picked-up and pumped to the high-pressure condensate tank in the boiler house. High-pressure steam from the preheaters dumps into the high-pressure condensate tank. Whatever make-up water is required is also pumped into this tank.

Cooling Tower

The cooling tower, with 15 bays and of the atmospheric type, has a two-system hookup. One system, in which the water is circulated by a 1125-r.p.m. centrifugal pump driven by a 20-hp. motor, picks up the water from the tower basin and discharges directly to the sprays serving the jacket water and primary coolers. This system also is arranged to control temperature on the coils through which pass reflux from the fractionating columns. On the other system a 35-hp. motor drives a 6-in. 1750-r.p.m. centrifugal pump that circulates water from the basin over the top of the tower. A similar unit serves as a standby.

Oil Reclamation

Absorption oil is taken from the bottom of the still and passed through a reclaiming unit where it is heated by steam to a temperature of 385°F., eliminating the impurities and leaving the oil reconditioned for return to the lean oil storage. This unit will reclaim 60 gal. of oil an hour.

Generating Equipment

Equipment for generating electricity consists of two 125-kw. generators driven by 200-hp. gas engines, one unit being used as a standby.

Compressed Air

Compressed air is provided by an automatically controlled 8 by 4½ by 8 steam-driven compressor as the main unit, and an auxiliary unit consisting of a 6 by 3½ by 5 compressor driven by a gasoline engine.

Processing Pumps

Pumps used in processing consist of the following, all steam-driven:

Raw make charge pump, 8 by 5 by 12.

De-ethanizer reflux pump, 6 by 5 by 12.

The standby for these two pumps is a 10 by 5 by 12.

Depropanizer reflux pump, 6 by 5 by 12.

Debutanizer reflux pump, 6 by 6 by 12.

De-isobutanizer reflux pump, 6 by 6 by 12.

The standby for these three pumps is a 6 by 6 by 12.

The abovementioned pumps are all of the close-clearance type; the following are simplex:

Two condensate pumps, 7½ by 4½ by 10.

Two dephlegmator reflux pumps, 8 by 5 by 12.

Gas Analyses

Numerous fractional analyses have been made both of the intake gas to the plant and of the residue gas. The following analyses are considered representative.

FRACTIONAL ANALYSIS OF INTAKE GAS

Component	*Gas volume, percent*	*Gal. per M. cu. ft.*
Methane	75.79	....
Ethane	9.25	....
Propane	6.69	1.84
*Iso*butane	1.49	0.49
n-butane	2.90	0.93
Pentanes plus	3.88	1.49
Total	100.00	4.75

FRACTIONAL ANALYSIS OF RESIDUE GAS

Component	*Gas volume, percent*	*Gal. per M. cu. ft.*
Methane	88.17	....
Ethane	9.09	....
Propane	2.74	0.75
Total	100.00	0.75

Contractor

Gasoline Plant Construction Corporation, Houston, Texas, acted in the capacity of designing and construction engineers, and built the plant in coöperation with engineers of the Warren Petroleum Corporation.

☆ ☆ ☆

Pipelines Untie Transportation Knots!

Pipelines don't wait for empty tank cars, highway haulers, barges or tankers to deadhead back. No demurrage. No lost time. No need for extra storage facilities. Economic conservation instead of waste. Faster, lower cost handling in any weather, reflected in lower cost to the producer, refiner, marketer and consumer. Pipelines—the better way!

And Buckeye Trenchers—the better way to get pipelines down. Faster for short loops or gasoline, natural gas and crude mainlines. Tough as a "leatherneck," they take it as it comes; no babying, no need to spar for an easy right-of-way. They trench in anything short of solid rock.

Plus values built into every Buckeye Pipeline Trencher assure maximum speed and lowest operating and maintenance costs on every trenching job—stress-proof support for the digging wheel, power-loss eliminating method of driving digging wheel, more rugged and more variable transmission, tougher non-clogging crawlers, and sharp-cutting cleaner dumping digging buckets. Gasoline or diesel power.

Get the facts and you'll get a Buckeye!

BUCKEYE TRACTION DITCHER CO.
Findlay, Ohio

Built by Buckeye

Convertible Shovels

Trenchers

Tractor Equipment

R-B Finegraders

Road Wideners

Spreaders

Statement on Revocation of P-83

Revocation of Preference Rating Order P-83 by the War Production Board means that, henceforth, oil industry supply houses will maintain minimum practical inventories through Preference Rating Order 98, the OPC announced April 18.

The OPC statement follows:

"Originally established to aid suppliers in bringing their inventories up to a minimum operating level, P-83 permitted supply houses to obtain materials on a quarterly basis. When WPB issued P-98 and Form PD-1-a, there was no further need to continue P-83. Hence, P-83 has been revoked.

"Under P-98, suppliers may maintain a 90-day stock of materials, or the equivalent of a minimum practical inventory. Suppliers may apply ratings to obtain materials scheduled to be delivered to an operator or to replace inventory material that already has been delivered to an operator.

"Under no circumstances, however, can a supplier apply for ratings under P-98 if he can make deliveries to the operator and still maintain a minimum practical inventory. If, in making deliveries, the supplier reduces his stock below the minimum inventory, he can use the rating applied by an operator only to the extent necessary to build up the inventory again to a minimum level.

"Manufacturers may apply ratings under P-98 to reacquire a minimum practical inventory only if the manufacturer applies the rating *before* he completes the delivery of materials rated by the operator.

"Suppliers, however, may defer application of ratings until they can place a purchase order or contract for the minimum quantity of materials obtainable under their customary terms. This provision was made so that suppliers who get reduced prices for bulk purchases can continue to obtain their usual terms.

"Suppliers electing to defer the application of their ratings, so as to make bulk purchases, must apply the ratings within three months after rating purchase orders have been received from operators.

"When ratings of orders under P-98 do not conveniently permit a supplier to maintain his inventory at a working level, he can apply for assistance under Form PD-1-a, or under the procedure called for when a conservation or limitation order is involved. These forms are checked and analyzed by the Office of Petroleum Co-ordinator before a rating is issued by the War Production Board."

Statement on Additives (Recommendation 40)

The following was issued April 23 by OPC:

"Wider latitude in the use of additives in extreme-pressure lubricants for passenger cars was authorized today by the Office of Petroleum Co-ordinator Harold L. Ickes in an amendment to a formal recommendation (No. 40 of the Co-ordinator).

"Under the original recommendation, which was issued on March 16, manufacturers and distributors of lubricating oils and greases were called upon to eliminate additives in extreme-pressure lubricants used in civilian passenger cars by substituting a straight mineral oil type lubricant for transmissions and by eliminating the manufacture of chassis lubricants containing an additive requiring chlorine in its manufacture.

"Now, manufacturers may use additives for passenger car lubricants but are called upon to reduce the amount used to 'whatever extent possible and practicable.'

"The reduction, however, must be at least 25 percent of the amount of additives used in extreme-pressure lubricants in the calendar year 1941. In computing this minimum reduction, manufacturers may allow an adjustment upward or downward in the direct proportion that civilian sales this year bear to 1941 sales.

"The amendment, by allowing flexibility in the use of additives for passenger car extreme-pressure lubricants, avoids the necessity of using steel for new equipment and at the same time reduces the quantity of additives used.

"Deputy Co-ordinator Ralph K. Davies stated that whereas the amendment permits marketers to use extreme-pressure lubricants containing additives in civilian passenger cars, at the same time it keeps the amount of additives used within the quantity allocated to the oil industry.

"The amendment also includes fire department cars among the vehicles that may use lubricants marked 'Not for use in passenger cars.'

"Manufacturers have been requested to report the results obtained through application of the recommendation. Under the original authorization, the reports were to have been forwarded to the Office of Petroleum Co-ordinator, Washington, D. C., within 45 days after the recommendation was issued. The amendment, however, calls for two reports and sets the dates: The first is to be forwarded on May 15 and the second on July 1."

Priorities for Foreign Operators

Delivery of materials required by operators of oil enterprises in foreign countries will be expedited by the foreign petroleum industry material rating plan, which has recently become effective, the OPC stated April 28.

The plan, issued by the War Production Board, does not affect operators whose businesses are in Canada or in the United States, its possessions, and its territories.

To obtain priority ratings under this plan, requests must be filed with the Board of Economic Warfare, Washington, D. C. The plan will terminate on September 30.

Form PD-311 will be used in applying for priority ratings. This form must be filed with the Board of Economic Warfare, where the data will be first considered for foreign clearance. The form will then be sent to the Office of Petroleum Co-ordinator for analysis as to the material needs of various petroleum operators. Then the information will be transmitted to the War Production Board, which will assign preference ratings.

If favorable action is taken upon a request for materials, the operator will be informed immediately. Before the operator can apply his preference ratings, however, he must obtain either from the Board of Economic Warfare or the Office of Lend-Lease Administration a Certificate of Assignment of Preference Ratings and an export license or a statement of authority to export.

Because requests for materials under the plan are reviewed by four agencies—OPC, WPB, BEW, and Lend-Lease—it is necessary that operators file six copies of all information accompanying Form PD-311, which also must be submitted in sextuplet. The six copies may be submitted as an original and five carbon copies, or, if the applicant desires copies for his own records, may be mimeographed.

As it is the policy of the four agencies that the supply of scarce material available for the petroleum industry be used as effectively as possible, Deputy Petroleum Co-ordinator Ralph K. Davies suggested that operators maintain inventories at a minimum practicable level.

When reviewing requests for materials, the agencies will take into consideration existing inventories and amounts previously used as compared with anticipated requirements. If an operator believes that this comparison does not adequately indicate his position with respect to certain items, he may submit additional information in a letter. This information also must be submitted in sextuplet.

In filling out Form PD-311, operators must distinguish material requirements according to one of five classes in which the materials are grouped. These are indicated in detail in the plan, mimeographed copies of which may be obtained by writing to OPC.

In addition, the plan requires that operators file separate PD-311 forms for each branch of the industry in which materials are required—production, refining, transportation, or marketing. Requests submitted to each branch should be for materials in that branch only.

Form PD-311 was drafted so that an operator can present all essential information in one application. It is based on discussions of policy concerning military needs for oil, materials supply, foreign relationship, shipping space, and other matters of critical importance.

"The use of Form PD-311 will simplify applications for priorities and will eliminate the use of a multiplicity of individual forms that otherwise would be required from an operator before the four agencies could consider an application," Davies said.

He added that oil companies thus can expect to receive materials much sooner through Form PD-311 than would be possible by the use of a combination of forms.

Each copy of the application submitted to the Board of Economic Warfare must be certified to by an authorized official of the company requesting the rating.

Asks Formulation of Oil-Field Development Program

The petroleum regulatory agencies of the oil-producing states were requested April 30 by the Office of Petroleum Co-ordinator Harold L. Ickes to assist operators in the formulation of oil-field development and production programs that will be of maximum benefit to the war effort.

Issued by Deputy Co-ordinator Ralph K. Davies, the appeal was made at the suggestion of the National Conference of Petroleum Regulatory Authorities. A resolution adopted by that Conference asked that the OPC "encourage regulatory bodies to co-operate with operators in filing pool applications for exceptions to M-68 by having hearings and transmitting transcripts of these hearings" to Washington for consideration and action.

M-68 is the War Production Board conservation order that prescribes basic requirements governing the spacing of oil and gas wells, the number of pumping units that may be installed, and the use of other production equipment.

The order requires oil wells to be drilled on 40-acre units and gas wells on 640-acre units, but permits the granting of exceptions whenever these are deemed necessary to promote the war effort.

"Approval of applications for exceptions to M-68 is not extended readily," Davies said, "and now that the materials shortage is even more critical, probably fewer exceptions will be granted than heretofore.

"Accordingly, there is a growing need for a concise, factual presentation of all engineering and other data that may be required to enable an exhaustive analysis of any application by the Office of Petroleum Co-ordinator.

"In the past, applications involving specific properties within a pool have been presented and considered by this Office, and occasionally approval recommended to and granted by the War Production Board. Individual applications will continue to be considered. But it is obviously preferable when exceptions are requested for a field as a whole.

"It is in the study of conditions and characteristics of a field as a whole that the petroleum regulatory body in a state may serve effectively to aid the operators in the field in determining the proper development program to effect the greatest recovery of petroleum with a minimum expenditure of critical materials.

"Often, a closer study of the provisions of M-68 by a group representing the operators in a field and the state regulatory body may disclose a plan of procedure that will conform fully with the order and eliminate the need for an exception. In other instances, the operators may avail themselves of the technical assistance of the regulatory agency in preparing an application for exception to the order that will present such a strong case in favor of the proposed exception that approval will be expedited."

Davies said there were several ways in which operators and the appropriate state regulatory body or commission could undertake the joint study of a development program:

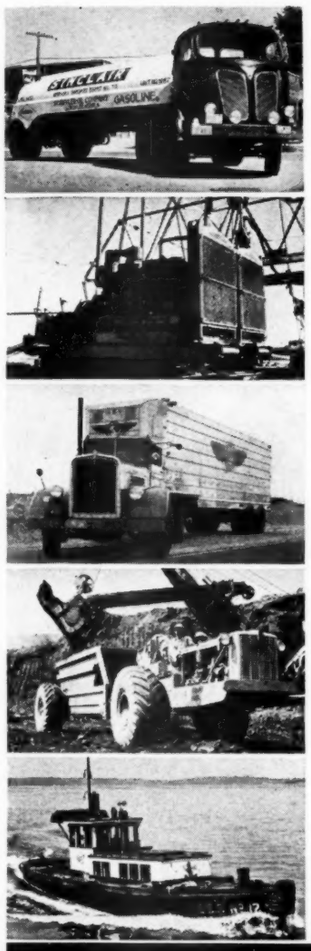
"One or more operators in a field could ask the agency to call a meeting of the operators. Or, perhaps the agency might recognize the need for concerted action in a field and call the operators' meeting itself. Inasmuch as a field study involves the consideration of engineering and other technical data, possibly an engineering or technical committee should be appointed to undertake the actual work.

"The state authorities should guide the selection of a drilling pattern for the entire field and the determination of the most logical geographic position in the drilling unit for the well locations."

When all the pertinent facts pertaining to a given field have been gathered and analyzed, then, if an exception to M-68 appears justified, there will exist a logical basis upon which to prepare the application. Applications governing a field as a whole should be prepared on OPC Form PD-214a, as revised.

The application, when completed, should be filed with the Office of Petroleum Co-ordinator by a group of operators or by one operator on behalf of the other operators in the field. The original and two copies of the application should be sent to the Washington Office and one copy should be forwarded to the appropriate District Office. Upon receipt of this information, the Office of Petroleum Co-ordinator will be in a position to determine the merit of the application for exception as it relates to the war program and to take the proper action.

——— ☆ ☆ ☆ ———



A NATURAL
for any job

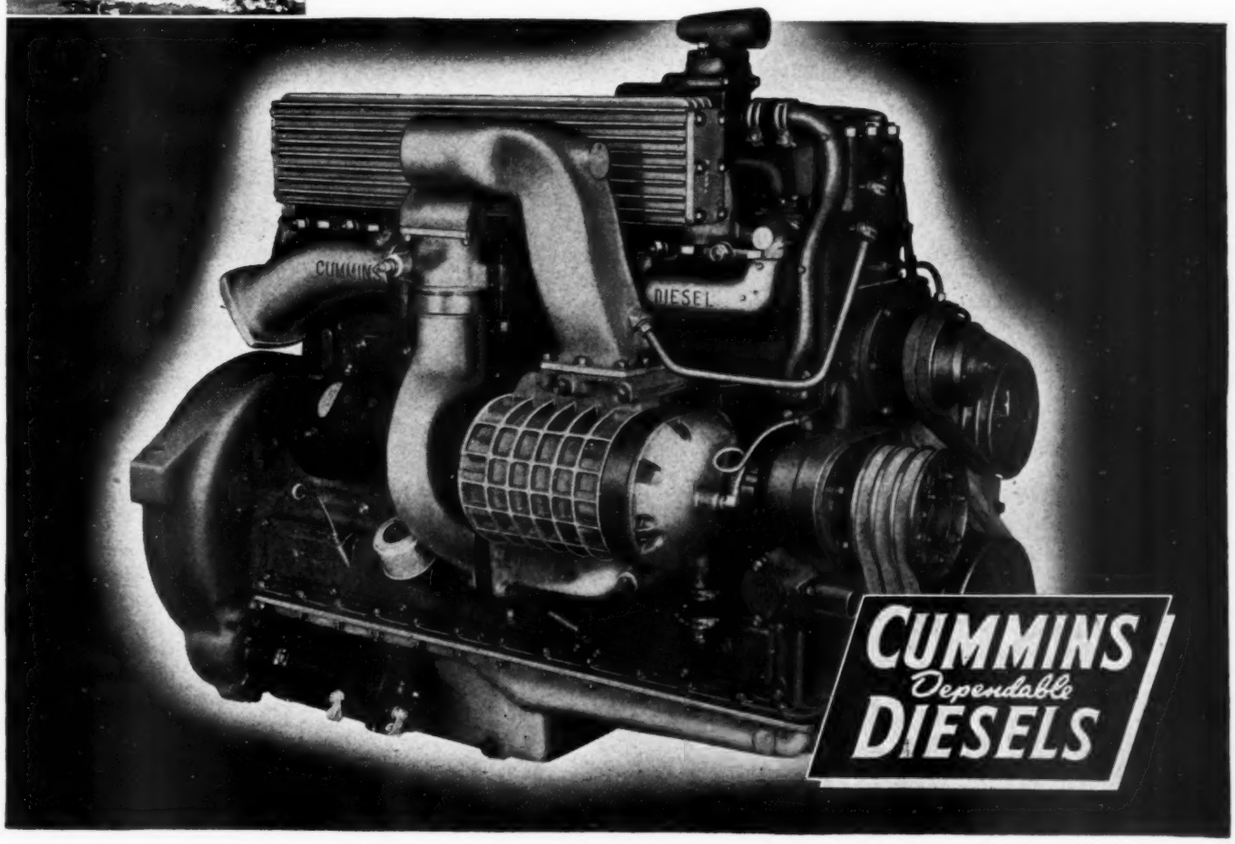
No matter what the service—heavy-duty trucking, construction, logging, oil well drilling, generating, marine power—Cummins Dependable Diesels are a *natural.* A *natural* because Cummins Dependable Diesels have proved their ready adaptability . . . their consistent, long-time dependability . . . their all-over economy, in the widest variety of applications . . . automotive . . . industrial . . . marine.

It is this record of proved performance in every heavy-duty service which explains the demand for Cummins Dependable Diesels for all types of National Defense work . . . that's why nine out of every ten Cummins Dependable Diesels are tagged for some preparedness job that demands power of unquestioned reliability. Cummins Engine Company, Columbus, Indiana.

MID-CONTINENT SUPPLY COMPANY • FORT WORTH, TEXAS

Distributors Mid-Continent Territory

Model HBS-600 (supercharged) Cummins Dependable Diesel. 200 hp. at 1800 rpm.



Chemical Reconditioning of Old Wells

Exclusive

☆ Although designed primarily as an acidizing tool, acid jet gun has many other applications

by J. H. Adkison
Dowell Incorporated

FIELD use of the acid jet gun has proved it to be of even greater value as an auxiliary tool for increasing the efficiency of chemical treatments of oil wells than laboratory tests initially indicated.

Although it was designed primarily as an acidizing tool, its application has been broadened so that it is now used as a means of selective re-acidizing, removing cement and mud sheaths, removing acid soluble cement retainers and cement plugs, cleaning out limestone cavings, and for minor deepening jobs. Also, it has been used in the removal of gyp and paraffin formations when ordinary circulation of acid has proved ineffective.

Application of the jet gun in operations in which acid is not the fluid medium, includes certain types of formation-cleaner treatments where paraffin solvent, butane, gasoline, kerosine, or low surface tension water may be used as a fluid agent.

Re-acidizing Old Wells

Re-acidizing or chemical reconditioning of old wells provides one of the most important adaptations of the jet gun. Many wells, particularly when multiple producing zones are evident, have been acidized shortly after completion by conventional methods. In such cases it is only reasonable to assume that the greater part of the acid entered the most porous and permeable of the saturated zones. A study of cores, cuttings, or particularly a review of an electric log of the well will usually indicate which sections of the formation are most likely to respond to selective acidizing.

A good example of selective re-acidizing occurred in the Salem pool, Marion County, Illinois.

The history of the well was that it had been completed at a total depth of 2057 ft. about 2 years previously in the McClosky Lime for an initial production of 39 bbl. an hour after being conventionally acidized with 3000 gal. of acid. Production had declined to less than 2 bbl. an hour. This well was deepened and found another streak of saturation from 2059 ft. to 2065 ft.

J. H. ADKISON

is a graduate of the University of Oklahoma, 1930, with B.S. degrees in mechanical engineering and petroleum engineering—His first oilfield experience was in New Mexico, 1930-31—From 1931 to 1936 was secretary of the Petroleum Division of A.S.M.E., Tulsa, Oklahoma—Joined staff of Dowell Incorporated in 1936 and for several years was engaged in development projects that included the jet gun described in this article—He is now district sales manager for Dowell at Midland, Texas.

This increased the production to 4 bbl. an hour, and the fluid level stood at approximately 1200 ft., which was the status of the well prior to using the jet gun method of re-acidizing. A 3-ft. section of the standard 4½-in. O.D. jet gun using 12 jets was attached to the lower end of the tubing, and the bottom 3 ft. of the producing formation was jetted with 1000 gal. of acid. Without shutting down the pump, the tubing was raised 3 ft. and another 1000 gal. of acid jetted against the upper 3 ft. of newly-exposed formation. The casinghead was left open throughout the jetting operation and, as the fluid level did not change, no attempt was made to force the acid into the formation by pumping oil-flush down the casing. The result of this treatment was to increase the production of the well from 100 bbl. a day before acidizing to 300 bbl. a day.

Another interesting case is that of an old well in Hutchinson County, Texas, in the Panhandle area. The well was completed and shot with 80 quarts in 1929, acidized in 1934 and increased from 15 bbl. a day to 140 bbl. a day. Re-acidizing in 1937 by a conventional method resulted in no increase. Production had declined to 7 bbl. a day. The jet gun and 3000 gal. of acid were then used and production increased to 120 bbl. a day.

Opening Blocked Formation

Drilling mud or cement slurry entering a porous saturated horizon often accounts for many wells showing only as light producers that otherwise would be good wells. Conventional acid treatments sometimes will remedy a condition of this type, but frequently this extraneous material in the pores effectively blocks the section against customary acid treatments. The acid jet gun has been a valuable aid in overcoming such blocks, and has proved to be a factor of value in improving the condition of old and new wells alike.

An instance of such a condition is that of a water disposal well in the Eldorado pool, Butler County, Kansas. After completion in the Siliceous lime, it was found that in cementing the casing, about 30 ft. of porous formation immediately under the casing seat was apparently cemented-off. The well would take only a few bbl. of water daily, and this only at high pressure. The jet gun and 1000 gal. of acid were used in making the treatment. The casing went on vacuum while the treatment was in progress. After being treated the well showed no pressure although 2500 bbl. of water a day were pumped into it. According to the operator this result was highly satisfactory and in his opinion was obtained with a smaller volume of acid than would otherwise have been required.

Similar procedures have been followed in the removal of mud and cement sheaths. Quick removal of such sheaths is effected by the jet gun in conjunction with small amounts of acid.

A well in Russell County, Kansas, was treated in which a cement sheath of 1½ in. to 2 in. in thickness remained on the face of the upper break in the Kansas City lime. This producing zone was completely sealed-off and

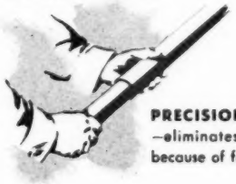
HOW *longer-life* Flupacos CAN HELP IN WARTIME!

WILL *the pump you buy today still be on the job a year from now . . . and the next year . . . and the next?* **If it's a new Flupaco pump, you can be sure of *longest* possible service, *least possible maintenance*, because these pumps today are outwearing many others as much as *5 to 1* under the toughest kind of pumping conditions. That's a performance point *vitally important* in your wartime pump maintenance program. Look at these Flupaco features:**

ONE-PIECE BARREL
—entirely eliminates disadvantages of jacket-plus-liner construction, gives higher production efficiencies.

SPECIAL HEAT TREATMENT
—makes full-length barrel 4 to 8 times harder on its wearing surfaces, doubles and triples service life.

MIRROR-FINISH HONING
—insures smooth, effortless plunger operation in barrel under all kinds of pumping conditions.



PRECISION ALIGNMENT
—eliminates uneven stroking because of free plunger travel.

FEWER REPLACEMENTS
—simple design reduces bulk, cuts weight in many cases to one-fourth of other pumps, eliminates *all* unnecessary parts.

So for your long range production program today, use top-performance Flupacos, pumps that are replacing bulky, costly types and streamlining entire production operations. Long-lived Flupaco "Groove Seals" and "Improved Insert" Pumps are available in a range of sizes, types, and metals for all conditions—and they're just as economical to buy as they are to use. See your Fluid Packed Pump representative—or write us direct—today—for the full details!

FLUID PACKED PUMP COMPANY, BOX 64, LOS NIETOS, CALIFORNIA

2 S. E. 29th ST., OKLAHOMA CITY, OKLA. ★ HUNT BLDG., TULSA, OKLA. ★ 2301 CONGRESS AVE., HOUSTON, TEXAS

WORLD'S LARGEST EXCLUSIVE OIL WELL PUMP MANUFACTURER

FOUR TIPS ON PUMP MAINTENANCE

to make present equipment last longer

1 Careful transportation:

Crate your pumps for long hauls, and handle carefully to avoid bending. Don't pile heavy objects on top of pumps, and make sure they are placed on a flat surface or are supported at close intervals. Wrap ends, but do not remove shipping or date tags.

2 Inspection:

After removing a pump from the well, clean it as quickly as possible to avoid unnecessary rusting. Lay pump flat on bench and inspect thoroughly. Check condition of pump anchor seat, and all accessible ball valves and seats. Use hydraulic pump to free sanded plunger. Use wrench flats provided when unscrewing parts, with end-wrenches to fit. Avoid applying excessive pressure or torque.

3 Repair and Reassembly:

Replace all worn parts with new ones, working with wrenches close to mating surfaces. Do not make up parts with excessive pressure—clean and lubricate threads first to avoid need for heavy strains. Make sure all valves are in proper position. When reassembled, tag and identify pump, giving all important specifications.

4 Systematic Storage:

Before storing, make sure all parts subject to rust are well oiled, greased or wrapped. Wrap accessories in moisture proof paper. Store so that pumps cannot be damaged.

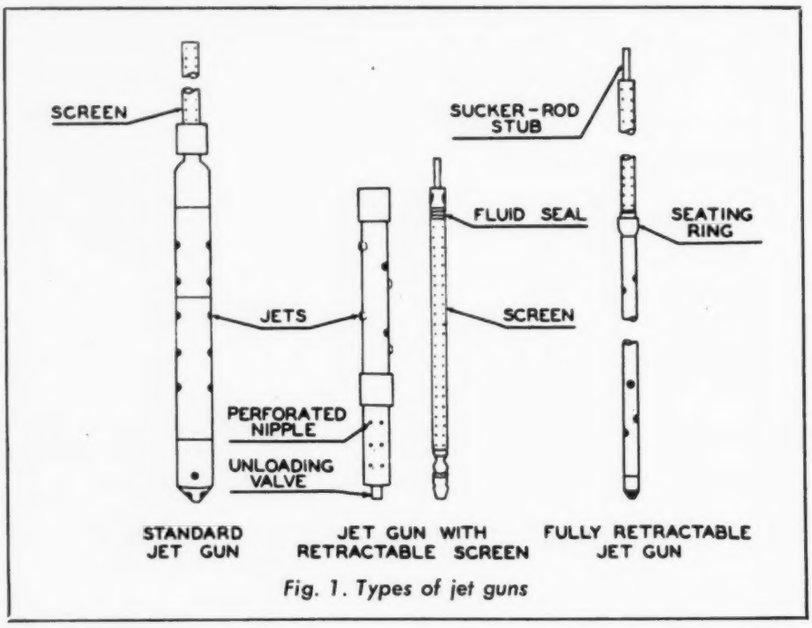


Fig. 1. Types of jet guns

no free oil was observed until the second and third breaks had been drilled. Even then the fill-up was only 750 ft. in 48 hours. One thousand gal. of acid were jetted against the upper pay break. Before the tubing could be pulled, the well had filled to 2650 ft. and, also, a satisfactory volume of gas was showing. After this, a second-stage conventional treatment resulted in the well making 1650 bbl. on potential.

Acid-Drilling of Cement Plugs

Another use for the jet gun is that of drilling-out cement plugs with acid, and also the drilling-in of wells with acid when casing is set on top of the producing lime formation. In acid-drilling practice, only a special jet gun drilling head is used. This is equipped with 3 downward 45° angular jets and a single downward vertical jet.

An excellent case illustrating acid-drilling of both cement plug and lime formation is that of a treatment made on a wildcat well in western Kentucky. The well was drilled to the McClosky lime and then 4¾-in. pipe was cemented to the top of the lime. An attempt to drill-in with 4-in cable tools resulted in the hole becoming key-seated, and progress was not being made beyond this point.

A jet gun consisting only of a special drilling head was run on the lower end of the tubing and drilling was begun by pumping acid through the jets. Circulation was established and jetting was continued for six hours. Eight ft. of hole was made, and the desired total depth was reached. This involved the removal of the cement plug and also some new drilling of the lime formation. The acid was subsequently squeezed into the formation.

The small-diameter casing combined with the comparatively shallow depth of the well permitted the accomplishment of this acid drilling job with only 1000 gal. of acid, as this was sufficient to establish and maintain circulation.

By setting the pipe close to the producing zone, the foregoing method of completion could be adopted as standard practice in areas producing from soft and highly soluble limestone horizons. The logical follow-up to such practice would be to squeeze the acid into the formation after the jet drilling is accomplished, thereby accomplishing two jobs (drilling-in and acidizing) at the same time.

Acidizing Gas Wells

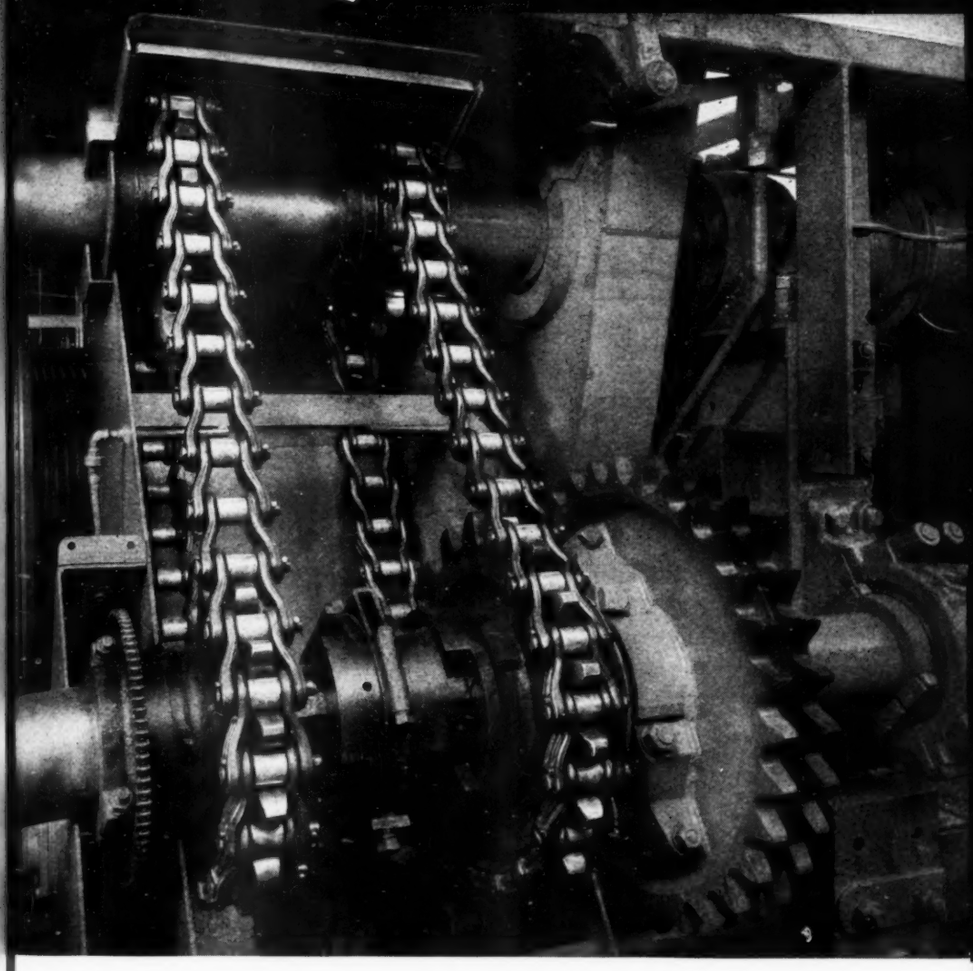
Customary practice in the acidizing of gas wells is to introduce the acid into the well by pumping the acid down the casing and then flushing the casing either with water or high-pressure gas. This sometimes results in only one pay break being acidized.

A conventional re-treatment of a gas well in Hutchinson County, Texas, was made in which the acid-gas interface was followed down with a measuring line and float. It was determined that only the upper section had been acidized, as the fluid level stopped some distance above the bottom of the hole and well above the lower producing section. This treatment resulted in an increase of only 1,694,000 cu. ft. a day. It was decided to use the jet gun and attempt re-acidizing the lower pay. Two thousand gal. of acid were jetted opposite the lower section. The measuring line and float were again used after the treatment, and the fluid level was found only 2 ft. off bottom, which indicated that the lower section had been satisfactorily acidized. The well responded with an increase of 9,500,000 cu. ft. per day.

Many old lime wells in West Texas were shot with nitroglycerine when completed. Subsequently, pumping troubles would arise from continued filling up of the open hole with lime cavings. The usual procedure was to move in a clean-out machine and remove the cavings by mechanical methods. From 15 to 18 days were usually required for a satisfactory work-over —a rather expensive operation. Jet gun acidizing has been highly successful in

Fig. 2. Equipment set up at a well preparatory to using the jet gun

"PUT LINK-BELT SUPER HYPER on the CHAIN DRIVES"



Customer's Orders

..."This Drawworks is headed for DEEP, FAST DRILLING SERVICE"

• Demands on steel emphasize today more than ever the value of certain oil industry manufacturers' ability to rebuild, like new, rotary drawworks which have seen long, hard service. Rig unitization, whether an oil bath job only, or complete modernization by rebuilding and replacement of vital working parts, is a major factor in near-future drilling. Pictured above is a unitizing job, including oil-bathing, nearing completion in Hunt Tool Co.'s Houston plant. When the guards go on, this drawworks will be on its way for deep drilling service . . . and will give new drawworks performance.

The drawworks drives are Link-Belt SUPER HYPER Chain, per orders of the owner. Like most rig owners, this operator knows that SUPER HYPER will successfully combat the stresses and strains of today's and tomorrow's heavier loads that come with faster, deeper drilling . . . that the design, materials and craftsmanship employed in producing this remarkable heavy duty chain mean extra strength, freedom from distortion, smoother performance, and longer chain life. Without question, most rig owners accept Link-Belt SUPER HYPER as the peak achievement toward oil field chain perfection.

Per customer's orders also, the engine drive will be Link-Belt SS-3125 HYPER, Double-width Chain. What more could any operator ask in new rig performance than the driving power of this combination of great chains!

LINK-BELT COMPANY

Leading Manufacturer of Mechanical Power Transmission Equipment

8631

Indianapolis Houston Dallas Los Angeles New York Toronto Distributors in all fields

LINK-BELT CHAINS

Fig. 3. Preparing to run jet gun into well

the removal of the cavings, and although complete removal of the cavings is not accomplished, the clean-out machine time is usually reduced to only two or three days. After such a treatment the wells are usually not subject to further caving of the lime section. Besides realizing the foregoing benefits, one operator reported that the production of his well, which was making only 10 bbl. a day, had increased to 75 bbl. a day.

A new service, which involves chemical cleaning of the face of the producing formation, employs the jet gun with very effective results. The material used is in the nature of a formation cleaner solvent, and when heavy asphaltic accumulations are evident on the face of the producing zones, the jet gun plus the cleaning solution or solvent has resulted in some remarkable increases in production. This type of service is also designed for the removal of "gyp" deposits, although the chemicals involved in the treatment are of an entirely different nature from those used on paraffin or other asphaltic accumulations.

Types of Jet Guns

The variety of uses and applications as outlined in the foregoing discussion at once revealed the necessity for several types and sizes of jet gun. In general there are three types now employed, with at least two sizes of each type available. Fig 1 illustrates the three types now in general use.

The standard jet gun (Fig. 1) is designed with provisions for lateral, angular, or vertical jets, or any combination. Improvements have been made recently that include a foot valve for unloading the tubing, and in addition to this, the jets are now recessed so that the face of the jet is flush with the body of the gun. Reverse circulation may be established with this type of gun merely by setting the jet gun on the bottom of the hole. This opens the foot valve and reverse circulation is established through the same ports and valves that are used for unloading.

The second type (center in Fig. 1) is one that permits removal of the screen assembly by means of a sand line, or measuring line, and a common sucker-rod socket. This leaves the jet-gun barrel and the bottom perforated nipple as a part of the tubing string and permits immediate production of the well without the necessity of round tripping the tubing. The design is for horizontal jetting only, and the gun is ideally suited for conventional acid jet treatments. It is also used quite extensively for the removal of scale or gyp deposits from the walls of the hole and for cleaning out paraffin or asphaltic accumulations.

The third type gun shown in Fig. 1 is fully retractable and has the strainer directly attached. A sucker-rod stub is mounted on the upper end, by means of which the entire gun may be recovered with a rod socket. This small gun may be provided with vertical, angular, and horizontal jets, and tends to make this an all-purpose jet gun. A safety factor is presented in vertical drilling as break-off and loss of the gun in the hole is prevented, inasmuch as the entire gun is lifted from its seat and pushed up the tubing should the gun be pressed against the bottom of the hole.

Strainers or screens were mentioned in the foregoing discussion of types and sizes of jet guns. These are an essential part of jet guns and serve the purpose of screening-out any foreign material that might plug the jets.

Results of Tests

Numerous tests have been conducted under simulated conditions on both cement test blocks and also on cores and blocks of lime. Cement test blocks were used for most of the experiments because of their known low solubility in hydrochloric acid; because their uniformity could be controlled better for several specimens, and because they could be obtained in thicker sections than samples of producing limestone formations.

Table 1 indicates that the most efficient and practical jet is 1/16 in. in diameter, as it provides excellent action, yet the pumping rate required is not excessive. The jets are the venturi type and are made either of stainless steel or Monel metal. The tests are based on a 3 in. distance between the jets and the face of the test block, with jet and block both submerged in 15 percent hydrochloric acid, the same as the jetting fluid. The jet sizes were varied in this series of tests.

The tests conducted in compiling Table 2 were based on using a 1/16-in. diameter jet and varying the distance from the jet to the face of the test block. Although impact pressures decrease rapidly as the distance from the jet to the test block is increased, there is evidence of removal action even to the extent of a 10 in. or 12 in. distance between the jet and test block.

The third set of tabulated results (Table 3) was made in the course of observing the effect of varying the concentration of the jetting medium. The distance and the size of jet were held constant.

TABLE 1

Jet dia., in.	Cement removed in 1 min., cu. in.	Max. depth of hole in 1 min., in.	Approx. dia. of hole, in.	Gal. acid per min., 1000 lb./sq. in. differential
3/64	5.08	1.5	4.5	1.835
1/16	11.30	2.75	3.25	3 375
5/64	13.28	2.25	5.5	5.125
3/32	15.18	2.75	6.0	8.19
1/8	19.30	3.5	8.0	14.0

Superior GAS ENGINES
... POWER FOR *ANY* PUMPING DEPTH

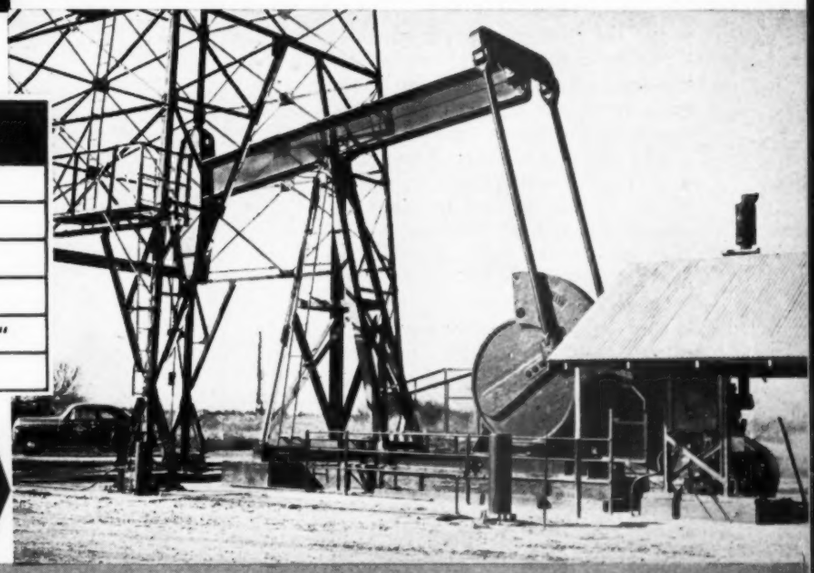
TYPE GB, the two-cycle, twin cylinder SUPERIOR GAS ENGINE whose dependable power assures continuous operation.

ON pumping installations in every oil field, Superior Gas Engines have established an unsurpassed record for economical performance and unfailing dependability. But nowhere is their outstanding ability more dramatically illustrated than on this lease near Coles Levee, California, where an ample, steady flow of Superior power, operating the largest pumper ever built, lifts oil from a depth of 8300 feet.

The wide range of Superior Gas Engine sizes, in both vertical and horizontal models, makes them adaptable to any pumping installation, from the largest to the smallest.

PERTINENT DATA	
ENGINE HORSEPOWER	50
ENGINE REVOLUTIONS PER MINUTE	500
LENGTH OF STROKE	10 FEET
STROKES PER MINUTE	10
SUCKER RODS	1", 7/8" and 3/4"
PLUNGERS	1¼"

A SUPERIOR GAS ENGINE Powers This Giant NATIONAL UNIT PUMPER



THE NATIONAL SUPPLY COMPANY

DOMESTIC { Executive Offices: Pittsburgh, Penna.; General Sales Office: Toledo, Ohio; Division Offices: Fort Worth, Texas; Tulsa, Okla., and Torrance, Calif.

EXPORT { The National Supply Corporation, 30 Rockefeller Plaza, New York, N.Y., U.S.A.; River Plate House, 12 South Place, London, E. C. 2, Limited Liability

The data in tables 1, 2, and 3 are interesting because they provide a basis for the establishment of limitations of

(1) Aiding in the selective acidizing of a formation.
(2) Cement or mud sheath removal.

TABLE 2

Distance between jet and test block, in.	Cement removed in 1 min., cu. in.	Depth of hole, in.	Average dia. of hole, in.
0	11.7	5.0	2.5
3	11.3	2.75	3.5
8	11.3	1.25	7.5
17	4.0	0.375	7.0

submerged acid drilling. The tables indicate that the three variables, (1) size of jets, (2) distance from jet to object, and (3) acid concentration, either singly or in any combination,

(3) Magnesium alloy retainer removal.
(4) Drilling-out cement plug.
(5) Deepening jobs of small magnitude in limestone.

TABLE 3

Percent HCl	Cement removed in 1 min., cu. in.	Max. depth of hole, in.	Average dia. of hole, in.
1.51	0.9	0.5	3.5
10.4	5.8	1.75	4.0
15.0	11.0	2.50	4.5
18.9	7.0	2.12	5.0
25.4	6.1	2.375	3.5

will have a pronounced effect on the efficiency of the action of the jets.

Conclusions

1. Various types of jet guns may be used advantageously in the chemical treatment of oil, gas, or input wells for:

(6) Removal of gyp deposits.
(7) Removal of paraffin deposits.

2. The action of the jet stream will be affected by:

(1) Design of the jetting nozzle.
(2) Acid concentration for cement or limestone.
(3) Chemical solubility of material being removed.
(4) Physical characteristics of material being removed.
(5) Differential pressure maintained.
(6) The distance of the jets from material being removed.
(7) The length of time jetted up to the critical point, when distance from the jet prevents further removal.
(8) Size of the jets being used.

3. Having the required differential pressure across the jets, the action is not affected by the hydrostatic column of fluid in the casing, as acid may be considered as incompressible, and therefore the viscosity of the fluid is unchanged.

4. The jet gun has definite limitations in regard to its maximum action and its effect on the permeability of a formation and the production increases that may reasonably be expected.

5. The jet gun will thoroughly prepare the formation of a well for a subsequent squeeze acidizing treatment, thereby increasing the efficiency in most acid treatments. To the well-informed operator, this auxiliary treating tool is well worth the additional preparatory work necessary for its successful application.

☆ ☆ ☆

P 623.3

Pipe Line Across River Hung Beneath Highway Bridge

IN constructing a pipe line recently for the Cities Service Gas Company, the Midwestern Engineering Company found it necessary to cross the South Canadian River. The line was hung beneath a bridge in the manner shown in the illustration.

The line is 16 in. in diameter and was welded throughout its 52-mile length by the shielded-arc process of electric welding with equipment supplied by The Lincoln Electric Company, Cleveland, Ohio.

Of no small importance to the speed in completing this project was the fact that the roll weld and tie-in method was used. Roll welding is commonly used in the construction of oil and gas pipe lines. Out in front of the entire construction gang goes the line-up and tacking crew. Aided by a tractor and hoist, they put the pipe lengths on ball-bearing dollies for rolling. The tack welders tack the adjacent lengths of the pipe together, usually at four points in the circumference. The tack welders join as many lengths as the nature of the line and the terrain will permit. The long tack-welded section is then left on the dollies ready for the "firing line" welders.

Showing manner in which pipe line is hung beneath highway bridge

The firing-line crew completes the welds of the long sections. These operators weld at the top of the pipe while a helper turns the pipe by means of a chain pipe wrench. Thus all welding is done in a flat, downhand position. By using large-size electrodes (¼ in., $\frac{5}{16}$ in., and sometimes ⅜ in.), and heavy welding current, high-speed welding can be obtained.

During the roll welding in this case, the welders averaged 34 welds an 8-hour day. On the bell-hole welds they averaged 20 welds per day.

☆ ☆ ☆

In Selecting Mud Valves

TAKE A TIP FROM MEN WHO KNOW—

Cameron-ize!

O. W. DYER
Drilling Contractor
1906 SECOND NATIONAL BANK BUILDING HOUSTON, TEXAS
Telephone C-6011
April 13, 1941.

....Cameron Flex-Seal Mud Valves are saving us 90% on mud valve maintenance.

O. W. Dyer, Sr.
O. W. Dyer, Jr.

CRON & GRACEY DRILLING CORPORATION
SUITE 1606 COMMERCE BUILDING
HOUSTON, TEXAS

September 4, 1941

....Cameron Flex-Seal Mud Valves have reduced our mud valve maintenance cost substantially.

CRON & GRACEY DRILLING CORPORATION
By Lon H. Cron
Lon H. Cron

ALLEN & MORRIS
DRILLING CONTRACTORS
ALAMO NATIONAL BUILDING
SAN ANTONIO, TEXAS

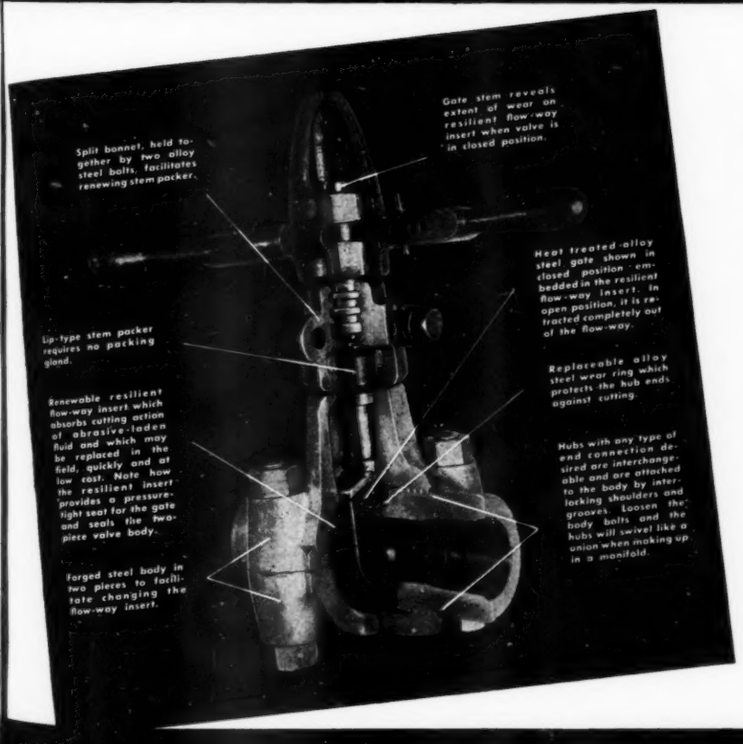
....Our Flex-Seal Mud Valve maintenance cost is extremely low.

ALLEN & MORRIS

J. S. ABERCROMBIE COMPANY
GULF BUILDING
HOUSTON, TEXAS

....Cameron Flex-Seal Mud Valves require 4¢ per 1000 feet of hole for maintenance at Old Ocean.

W. W. McNeal, Jr.
Purchasing Agent


Split bonnet, held together by two alloy steel bolts, facilitates renewing stem packer.
Gate stem reveals extent of wear on resilient flow-way insert when valve is in closed position.
Heat treated alloy steel gate shown in closed position embedded in the resilient flow-way insert. In open position, it is retracted completely out of the flow-way.
Lip-type stem packer requires no packing gland.
Renewable resilient flow-way insert which absorbs cutting action of abrasive-laden fluid and which may be replaced in the field, quickly and at low cost. Note how the resilient insert provides a pressure-tight seat for the gate and seals the two-piece valve body.
Replaceable alloy steel wear ring which protects the hub ends against cutting.
Hubs with any type of end connection desired are interchangeable and are attached to the body by interlocking shoulders and grooves. Loosen the body bolts and the hubs will swivel like a union when making up in a manifold.
Forged steel body in two pieces to facilitate changing the flow-way insert.

Small items of rig maintenance, such as the up-keep cost of conventional mud line valves and stop cocks, add up to a surprisingly high figure. Take, for example, the experience of such operators as O. W. Dyer, Cron & Gracey, Allen & Morris, J. S. Abercrombie and others, whose records reveal that the conventional mud line valve requires approximately $22.50 for repairs per 10,000 feet of hole drilled. *After installing Cameron Flex-Seal Mud Valves these operators report savings in maintenance ranging up to 93%.*

Today, with curtailed drilling operations, it behooves every rig owner to buy only that equipment which assures maximum return per dollar invested, and which requires a minimum of critical material for maintenance. From this standpoint, Cameron Flex-Seal Mud Valves have no equal. Add to this such features as: Easy field repair, interchangeable parts, a pressure-tight seal, and the reason why this valve is the fastest selling mud valve in the field becomes obvious.

Consult your Composite Catalog for complete mechanical details, or descriptive literature will gladly be sent on request.

NOW AVAILABLE IN 2000 AND 4000 LB. TEST MODELS SIMILAR TO THIS 6000 LB. TEST MODEL

CAMERON IRON WORKS, INC.

Running Tour

WITH MEN IN THE INDUSTRY

E. W. "AL" FARROW is now the representative for Mission Manufacturing Company, Houston, Texas, in the State of California. Farrow was formerly sales manager for the Security Engineering Company and succeeds RALPH CLEMONS, who is now employed by the Petroleum Equipment Company.

WILLIAM G. "BILL" BREWSTER, pioneer oil-well surveyor, died at Foster Memorial Hospital, Ventura, California, April 26. Brewster began his career in the surveying of oil wells in 1924, with Alexander Anderson. He went to the Eastman Oil Well Survey Company in 1932 and was employed by that company at the time of his death.

A. D. DENNIS has been appointed secretary-treasurer of the LaPlant-Choate Manufacturing Company, Inc., Cedar Rapids, Iowa. Dennis is a certified public accountant and has been an internal revenue agent for the last six years.

M. ZIMMELMAN, engineer for the American Rolling Mill Company, Argentina, South America, recently completed a business visit through the Mid-Continent and Gulf Coast fields.

T. F. HUDGINS and STANLEY E. JOHNSON, of the Cooper-Bessemer Corporation, Mt. Vernon, Ohio, attended the American Gas Association, Natural Gas Section, annual convention, at New Orleans, Louisiana, May 4, 5, 6, and 7. Before returning to Ohio, they visited in the Gulf Coast area.

R. S. "BOB" CHRISTIE, division engineer for Texas and New Mexico for the Amerada Petroleum Corporation, has been ordered to report to Fort Rosecrans, San Diego, California, as a first lieutenant in the Coast Artillery.

H. W. DODGE has been appointed assistant deputy director of the War Production Board's materials division in Washington, D. C. Dodge was formerly vice-president and sales manager of The Texas Company. His new appointment places him as third ranking official in the division.

T. H. BARTON, recently was re-elected chairman of the board and president of the Lion Oil Refining Company, El Dorado, Arkansas, at a stockholders meeting. All officers and directors of the company were re-elected.

E. E. ROBBINS, of the Office of Petroleum Coördinator, District 2, has closed the Tulsa, Oklahoma, office and returned to Washington, D. C., to assume duties there. The Chicago, Illinois, office will handle P-98 orders formerly handled by Robbins.

N. P. WHALEY, formerly in charge of the Tulsa, Oklahoma, office of Sands Petroleum Company, has been elected vice-president and director of the company, according to an announcement by WILLIAM HUTCHINSON and RAY H. BEEMAN, president and vice-president, respectively.

J. A. NEATH has become a member of the board of directors of the Humble Oil and Refining Company and has resigned as vice-president of the Humble Pipe Line Company. He succeeds JAMES ANDERSON, who has retired as vice-president and member of the board. D. B. HARRIS, also a member of the board of directors, has been named treasurer of the company. He is also director in charge of industrial relations.

DR. SAMUEL T. YUSTER, of State College, Pennsylvania, has received appointment as the Pennsylvania member of the research and coördinating committee of the Interstate Oil Compact Commission. Yuster is associate professor of petroleum and natural gas engineering and is in charge of petroleum production research in the mineral industries experiment that is sponsored by the Bradford district research group and the Pennsylvania Grade Crude Oil Association.

GEORGE D. MORGAN, president of the Cardinal Oil Company, has organized the Cardinal Drilling Company with headquarters in San Angelo, Texas. Morgan will serve as president. Other officers are CLAUDE E. AIKMAN and J. V. SCHILLING.

DR. LUIS ALEJANDRO DEL RIO is now chief geophysicist in the office of the Ministry of Mines and Petroleum of the Colombian government. The new chief is a graduate of the Colorado School of Mines.

J. H. CROMWELL, H. W. LEWIS, and I. W. MURFIN, with New York interests, have organized the Three Way Oil Company to operate in Kansas.

TED A. CHAPMAN, Wichita, Kansas, was recently elected president of Drillers Supply Company of Wichita. Chapman is president of the Southern Supply Company and succeeds J. R. BALLARD as president of Drillers Supply Company.

T. VREELAND, formerly sales manager of the Colton, California, district for General Petroleum Corporation, has been promoted to manager of fuel-oil sales.

L. B. PARK is now geophysicist with the Atlantic Refining Company, Midland, Texas, succeeding A. E. MCKAY, now a lieutenant in the U. S. Army.

PAUL WEAVER, of the Gulf Oil Corporation, Houston, Texas, and vice-president of the American Association of Petroleum Geologists, delivered an address to the Fort Worth, Texas, Geological Society recently on "The Evaporite Series: Their Influence on War Economy With Particular Reference to Potash and Magnesium Deposits in Germany."

B. F. JONES, general counsel of Standard Oil Company of Indiana, is now a member of the board of directors. He joined the company in 1930 as an attorney and before becoming general counsel in 1940 was senior general attorney.

J. E. CLAYTON, superintendent, Humble Oil and Refining Company, has been transferred from the Lovell Lake repressuring plant to the Katy gas cycling plant. Other personnel changes by the company are as follows: J. R. CARROLL has been appointed plant superintendent in charge of the Lovell Lake repressuring plant succeeding Clayton. M. H. BUCHANON has transferred from Friendswood to Galveston Bay area as district transportation foreman. B. B. INGRAM, junior petroleum engineer, has been appointed district petroleum engineer in the Wasson district. ED. LOGGINGS has been transferred from North Crowley to Paradis and promoted from electrician to district electrical foreman.

For Longer Trouble-Free

PUMP PERFORMANCE

MISSION *Super-Surfaced* PISTON RODS

. . . stay in your pumps from two to four times longer. This extra long life is due to the *double wearing surface.*

Wearing Surface No. 1

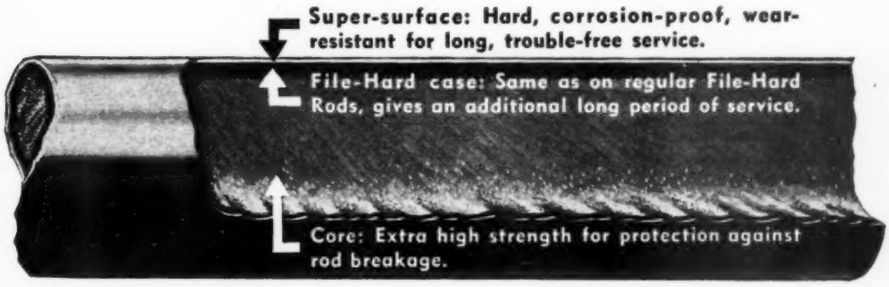
This hard, corrosion-proof, wear-resistant super-surface lasts longer than the regular File-Hard Rod under ordinary conditions . . . and up to three times longer under corrosive conditions.

Wearing Surface No. 2

When the super-surface is finally worn off, a regular Mission File Hard Surface remains to give you another long period of service.

Longer Rod Life Means Lower Rod Costs

From two to four times longer life at only about a 45% increase in price . . . This means lower rod costs any way you figure it; in most instances at least a two to one saving. Install these rods in your pumps and start saving right away.


Super-surface: Hard, corrosion-proof, wear-resistant for long, trouble-free service.
File-Hard case: Same as on regular File-Hard Rods, gives an additional long period of service.
Core: Extra high strength for protection against rod breakage.

MISSION *Self-Sealing* GLAND PACKINGS

. . . seal perfectly regardless of pump pressure. This means longer rod and packing wear as well as freedom from frequent tightening of gland nuts.

Self-Sealing Principle: This outstanding performance is possible because pump pressure, acting on the packing lip, gives a seal which varies with pressure—there is no binding at low pressures—no leakage at high pressures.

Order several sets of Mission Self-Sealing Gland Packings. They will make your rods last longer and save you trouble.

MISSION FLUID END PISTONS

. . . save you the cost of the piston body every time you change rubbers. With Mission, you simply dress up the piston body with new rubbers.

You get a double saving because, in addition to saving piston body costs, the tough, durable Mission Piston Rubbers stay in your pumps longer.

"Change the Rubbers and Save the Piston."

MISSION MANUFACTURING CO.
Humble Road Houston, Texas
EXPORT OFFICE: 30 Rockefeller Plaza, New York

MISSION
SLUSH PUMP PARTS

E. C. WELLS, formerly engineer for the Carter Oil Company, Magnolia, Arkansas, is now a lieutenant at Fort Benning, Georgia, in the U. S. Army.

H. E. GREENWOOD has succeeded NEIL STALLARD as manager of the Valley Pipe Line Company, McAllen, Texas. Greenwood is from Louisiana.

CAPTAIN B. B. HOWARD, vice-president of the Standard Oil Company of New Jersey, and manager of the Marine Department, has been elected to the directorship of the Maritime Association of the Port of New York.

G. L. GARDINER, formerly manager of distilling units for the Shell Oil Company at Martinez, California, has been appointed superintendent of the Shellborn, B. C., refinery owned by the company. He will establish his headquarters in Vancouver, B. C.

S. R. HARDING and H. A. MCOWEN, formerly with Olympic Refining Company and Harbor Refining Company, respectively, have resigned to become associated with the Comet Oil Company.

J. W. STOKER, Sinclair Prairie Oil Company, production superintendent, Shidler, Oklahoma, has been transferred to the Cushing district with headquarters in Drumright, Oklahoma.

N. W. SHIARELLA, president of the Kentucky Oil and Gas Association, and a member of the companies of Miller and Shiarella and Basin Drilling Company, has been appointed a "Kentucky Colonel" in recognition of his efforts in the interest of the oil and gas industry in Kentucky. The appointment was made by Governor Keen Johnson.

R. R. GOLDSMITH, tool pusher in the drilling department of the Phillips Petroleum Company, is now at the Phillips camp at Rock Crossing, Texas, as supervisor of the wells being drilled on the Wagner lease.

T. A. DINES, president of the United States National Bank, Denver, Colorado, and of Utah Oil Refining Company, Salt Lake City, Utah, subsidiary of Standard Oil Company of Indiana, is now a director and president of Mountain Producers Corporation, succeeding the late J. T. BARNETT.

W. W. ROBINSON, The Texas Company, recently delivered an address before the Los Angeles, California, Chapter of the American Institute of Mining and Metallurgical Engineers, entitled "The Practical Side of Synthetic Rubber."

D. R. JOHNSON has been promoted to superintendent of the Continental Oil Company's refinery at Ponca City, Oklahoma, succeeding FRED G. FELLOWS, resigned, according to an announcement by WALTER MILLER, president of the company. Johnson has been associated with Continental for the last 18 years, having joined the or-

D. R. JOHNSON

ganization at Glenrock, Wyoming, as an electrician in 1924. He was transferred to Ponca City in 1929 as inspection supervisor and later became chief inspector. In October, 1941, he became assistant superintendent. Due to increased volume of work brought about by changes in processing to manufacture special products for war use in the refinery, an additional position of assistant superintendent has been established. H. A. MERTZ, formerly superintendent of construction in the engineering department, and L. L. SMITH, formerly superintendent of the Denver, Colorado, refinery, are the new assistant superintendents. Mertz has been with the company since 1917 and Smith since 1924.

T. A. MORGAN, formerly division engineer for the Houston Natural Gasoline Corporation, Houston, Texas, is now valuation engineer, succeeding the late C. H. E. HORN.

J. M. PRITCHARD, president of McColl-Frontenac Oil Company, has been elected president of Montreal Aircraft Industries, Ltd., of Montreal, Quebec.

WILLIAM OSMOND, Shell Oil Company, Inc., engineer, has been transferred from Jacksboro, Texas, to Wewoka, Oklahoma.

H. A. DUTCHER and D. J. BANKFORD are now members of the Bartlesville, Oklahoma, experiment station of the U. S. Bureau of Mines. Dutcher is formerly of Tulsa, Oklahoma, and Bankford of Beaumont, Texas.

F. M. ERVIN, petroleum engineer, who was formerly located in Egypt for the Shell Oil Company, Inc., has enlisted in the Army Engineering Corps.

MAJOR H. H. MORSE, formerly in the research department of Phillips Petroleum Company, in Bartlesville, Oklahoma, was recently transferred from the ordnance department in San Antonio, Texas, to commanding officer of the new Pueblo ordnance department now under construction.

HARRY H. NOWLAN has opened an office in Evansville, Indiana, as geologist and consulting engineer.

T. B. CHISHOLM, W. P. DURBIN, S. G. MCARTHUR, and E. F. STEPHENS have formed the Georgia Oil and Gas Company to drill a number of wildcat tests in Southwest Georgia.

LEE MINTER, engineer for the Belmont Quadrangle Drilling Corporation, Medina, Ohio, has been transferred to Bradford, Pennsylvania.

G. D. CHASTAIN, vice-president of the Mich-Ranger Oil Company, Ranger, Texas, has transferred to Mount Pleasant, Michigan.

A. W. BILLINGS was reelected president of the Signal Petroleum Company at the annual meeting of the company held in Los Angeles, California. Reelected to other offices were LYLE GARNER, vice-president and general manager, and L. TATE, secretary.

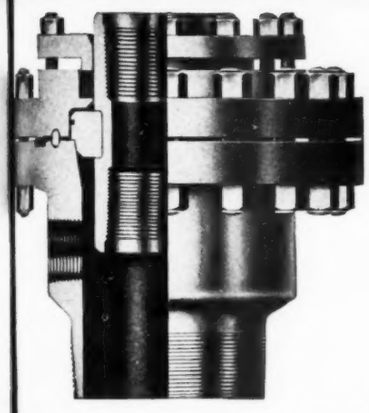
LESTER LEFAVER, formerly district foreman in Michigan for the Gulf Refining Company, has been transferred to Hobbs, New Mexico, effective June 1. He will be succeeded by O. L. STEVENSON, transferring from the Kansas division of the company. An inspection tour of company properties in Michigan was made recently by A. M. BELL, assistant general superintendent, and TED RAKESTRAW, drilling engineer.

VAILE HENRY has received appointment as deputy supervisor of District 3, of the Texas Railroad Commission. His headquarters will be in Houston. Henry succeeds O. P. NEWMAN, resigned, and has been with the commission in the oil and gas division for the last eight years.

R. S. JACKSON was recently elected a vice-president of the Independent Exploration Company, Houston, Texas, according to an announcement by T. I. HARKINS, president. In addition to his duties as vice-president, Jackson is also a field supervisor.

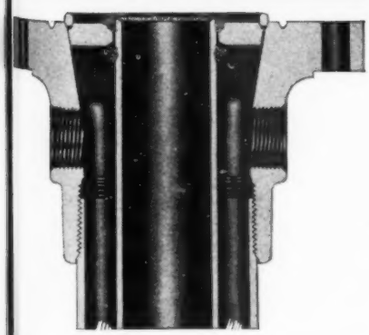
HEADQUARTERS FOR *Safer* WELL HEADS

SPLIT RING—RECESSED COUPLING
RECTORHEAD proved by more than 11 years trouble-free service.



...pe "AH," 6,000 lb. test, Series 900 API Flange is ...t manganese-molybdenum steel, normalized and ...t treated. Split ring and recessed coupling are ...mmer forged steel. Standard API seal ring packs ...d in flange, with two rows of ½" hydraulic pack... ...g for emergency only. Furnished regularly with ...ble threaded body, and Grade "D" threads ...ughout. Two side outlets threaded for 3" API line ...pe... (flanged if desired).

DOUBLE WELD MANDREL SUSPENSION
Simple—Safe—Dependable.



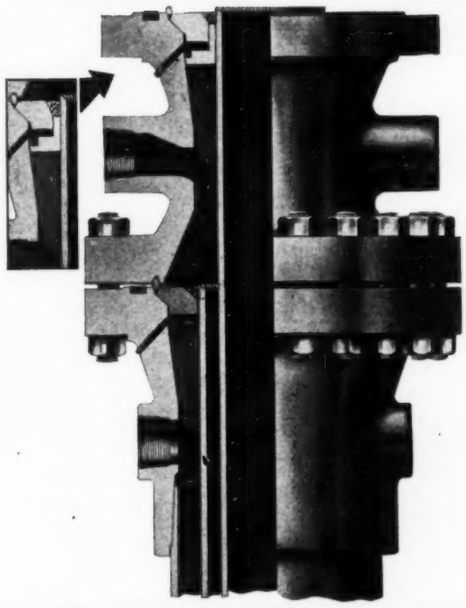
...Mandrel Suspension type RECTORHEAD Casing ...ds are of the most simple type of construction, ...g either a safe and thoroughly dependable method ...ding suspension and pressure seal. The REC...EAD shown above is the 9M (or 6M) RECTOR...D with double welding arrangement. Lower ring ...lit vertically so that it may be applied around ...g before cutting off. After lower ring is welded ...casing is cut off, the upper solid ring is applied ...welded to the casing, to form a gas tight seal. ...also be furnished with threaded mandrel.

Whatever your drilling, completion or production problem, there's a RECTORHEAD to meet your needs.

Rector's reputation for safer well control was earned the slow and hard way... through thousands of dependable installations. And everytime a new RECTORHEAD goes to the field, that reputation of years standing is at stake. That's why you'll find the RECTOR man in your territory so thorough... why he works on your problem individually... and why, too, you'll find the RECTORHEAD installed on your well will do the job completely, safely... whether for casing or tubing suspension.

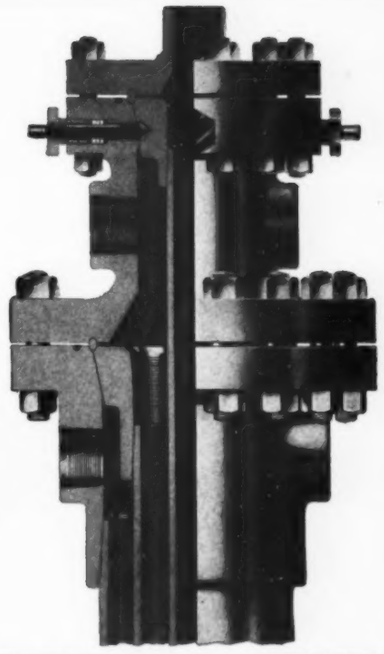
Get in touch with your local Rector representative. See the 1942 Composite Catalog for full details on all RECTORHEADS.

RH SLIP SUSPENSION RECTORHEAD
features Rector's patented pressure sealing and casing hold-down medium.



The "RH" Slip Suspension RECTORHEAD is extremely simple in design, and easily and quickly installed by the use of the exclusive RECTOR patented pressure sealing and casing hold-down medium... this being a Standard API seal ring in conjunction with a steel ring (above slips) welded to casing after slips are set. The design of this ring makes possible a secure and thoroughly dependable weld. Shown above is the Type RH Slip and Welding Ring Suspension RECTORHEADS for three strings of casing. Lower section shows single welding ring, upper section shows double welding ring.

MANDREL SUSPENSION TUBING HEAD



The Mandrel Suspension Type RECTORHEAD Tubing Heads incorporate the RECTOR Patented Pressure Sealing and Hold-Down Medium, using a single seal ring, acting dually as a pressure seal and mandrel hold-down. They conform to API specificiations in every respect. No soft packing used to seal between strings. Shown above is the Double Flanged Type Mandrel Suspension Tubing Head with Mandrel Locking Screws Flanged to "9M" Mandrel Type Casing Head.

RECTOR WELL EQUIPMENT CO. INC.
"MAKING THE OIL INDUSTRY SAFER"

RECTOR WELL EQUIPMENT CO., *Inc.*
FORT WORTH, TEXAS, U. S. A.
Representatives in All Active Drilling Areas
EXPORT AGENT:
Lucey Export Corporation, Woolworth Bldg., N. Y. C.
Sold by Leading Supply Companies

In the interest of conservation, we ask that you send in your old RECTORHEADS from abandoned wells for reconditioning whenever you can.

LAUGH WITH BARNEY

A chemist says that the first alcohol was distilled in Arabia, which may explain those nights.

* * *

I think that I shall never see
A girl refuse a meal that's free;
A girl with hungry eyes not fixed
Upon a drink that's being mixed;
A girl who doesn't like to wear
A lot of junk to match her hair;
Girls are loved by guys like me—
For who in the hell will kiss a tree!

* * *

Grade School Teacher: Where does God live?

Small Boy: In our bathroom.

Grade School Teacher: Why do you think that?

Small Boy: Because every morning my dad goes to the bathroom door and yells, "God! Are you still in there!"

* * *

A little old lady was being examined by the family doctor, having been sent there by her relatives for what they considered eccentricities.

"I just adore buckwheat cakes, doctor," the little old lady confessed.

"Well, there's nothing wrong about that," the doctor said with a smile. "I love buckwheat cakes myself."

The little old lady beamed. "Oh, you must come over to my house soon. I've got seven trunkfuls!"

* * *

"Perkins, Parkins, Peckham and Potts—good morning."

"I want to speak to Mr. Perkins."

"Who's calling, please?"

"Mr. Pincham of Pincham, Pettem, Poppum and Pogg."

"Just one moment, please, I'll connect you with Mr. Perkins' office."

"Hello, Mr. Perkins' office."

"I want to speak to Mr. Perkins."

"Mr. Perkins? I'll see if he is in. Who's calling, please?"

"Mr. Pincham."

"Just one moment, Mr. Pincham. Here's Mr. Perkins. Put Mr. Pincham on, please."

"Just one moment, please, I have Mr. Pincham right here. Okay with Perkins, Parkins, Peckham and Potts, Mr. Pincham. Go ahead."

"Lo, Joe? How's about lunch?"

"Okay."

* * *

A farmer is a man who makes his money on the farm and spends it in town, while an agriculturist is a man who makes his money in town and spends it on the farm.

During a lull in A.E.F. activities in London last week, a colored boy from Chattanooga got in a poker game with a few English chaps. Picking up his cards he found four aces. Someone had just bet one pound and the colored boy said, "I don't know how yo' boys count yo' money, but I'll just raise yo' one ton."

* * *

"Nowadays the early bird isn't so sure of getting the worm."

"No, he's much more apt to get his own breakfast."

* * *

Visitor (to Mussolini): Why are you holding up that umbrella? The sky is blue and there's no rain.

Mussolini: Ah, but it's raining in Berlin.

* * *

He: I think I've got a flat tire.

She: I think that makes us even.

* * *

"If I take this castor oil do you think I'll be well enough to get up in the morning?"

"Well—you'd better!"

* * *

Mrs. Meeker: John!

Mr. Meeker: Yes, dear.

Mrs. Meeker: There's a corner torn off your pay check. What did you spend it for?

* * *

The salesman whose pants wear out before his shoes is making too many contacts at the wrong places.

* * *

Gladys: Why did you break off your engagement with that good-looking young doctor?

Sally: Oh, it was his awful writing. Every time I had a letter from him I had to take it to a druggist to find out what was in it.

* * *

Jones: Here's that last pair of trousers you made for me. I want them reseated. You know, I sit a lot.

Tailor: Yes, and I hope you've brought the bill to be receipted. You know I've stood a lot.

* * *

Every famous man's wife has an uneasy feeling that something will happen to open the world's eyes.

* * *

The Japs have always kept up with our Big League baseball, so they ought to know that the Yankees have a habit of finishing on top.

Angry Father (at 2:00 a.m.): Well, young lady, where have you been until this hour?

Daughter: I've been sitting up with the son of the sick man you tell mother you were sitting up with.

* * *

George: My wife fooled me when we were engaged.

Robert: Why, what do you mean?

George: Well, when I asked her to marry me, she said she was agreeable.

* * *

Rabbit: We certainly know how to multiply.

Snake: I'm a tricky little adder myself.

* * *

Sue: Is your husband stingy?

Mary: I'll say! Why, every time he takes a penny out of his pocket the Indian blinks at the light!

* * *

Marine: These new shoes of mine are killing my feet.

Chorine: They're killing mine too!

* * *

Marine Corporal (at party): Do you know that ugly sap of an officer standing over there?

Gal: Do you know who I am? I am that officer's daughter.

Corporal: Do you know who I am?

Gal: No.

Corporal: Thank goodness!

* * *

She Was Only

A sentry's daughter but she never said halt.
A pacifist's daughter but she puts up an awful fight.
A commander's daughter but she never leads men on.
An intelligence officer's daughter but she never has a code.
A gunner's daughter but she certainly was a sight.

* * *

Customer: Are these field glasses high powered?

Clerk: You said it. When you look at something less than ten miles away it looks as though it was behind you!

* * *

Rastus: What all did de doctor say's de matter wid you?

Liza: He says I's sufferin' from acute indiscretion.

* * *

Magistrate (to man accused of begging): What have you to say?

Prisoner: It wasn't my fault, sir. I just held out my hand to see if it was raining, and the gent dropped a dime in it.

* * *

Advertising

From a Titusville (Pa.) newspaper: "Auctioneering is my special line of business. Prices very reasonable. If I am out arrange dates with my wife."

THE *Petroleum* Engineer's CONTINUOUS TABLES

A DAILY REFERENCE FOR OPERATING MEN

INSTALLMENT No. 59

THE tables on the following pages are designed to save time and effort for the technician, and to assist the practical field or plant worker to solve problems commonly encountered in routine work. They are not intended nor expected to supplant technical training and make every man his own designer. Most of the tables can be understood and applied by anyone acquainted with the simple fundamentals of mathematics.

For the convenience of readers who wish to refer to the tables, each page carries in the upper right corner an index number that classifies the table according to subject matter.

All petroleum engineering literature may be indexed for reference according to the Dewey Decimal System as modified and extended for the petroleum industry by L. C. Uren, professor of petroleum engineering at the University of California. When classified according to these index numbers the material follows in a logical sequence and falls into several natural divisions, as illustrated by the following outline:

Nos. P000-P399—General
Nos. P400-P499—Drilling
Nos. P500-P599—Production
Nos. P600-P699—Transportation and Storage (includes Pipe Line)
Nos. P700-P799—Refining, including
Nos. P770-P799—Natural Gasoline, which may be classified in a separate division (as shown here) if of special interest to the user

To aid the reader in using the Decimal System, a subject index arranged alphabetically has been published, and is available at a cost of 50 cents per copy from *The Petroleum Engineer*, P. O. Box 1589, Dallas, Texas.

INDEX TO TABLES*

Title of Table	*Index No.*	*Page*	*Issue*
Squares of whole numbers	P 061.001.1	131	Nov.
Squares of whole numbers	P 061.001.2	119	Feb.
Squares of whole numbers	P 061.001.3	111	Apr.
Square roots of whole numbers	P 061.002.1	119	Dec.
Square roots of whole numbers	P 061.002.1	103	Apr.
Cube roots of whole numbers	P 061.003.1	109	Dec.
Cube roots of whole numbers	P 061.003.1	185	May
Conversion tables—Foreign weight units (sheet 1)	P 066.002.	101	Jan.
Conversion tables—Foreign weight units (sheet 2)	P 066.002.	117	Feb.
Conversion tables—Foreign volume units	P 066.003.	105	Jan.
Equivalents—gravity, volume, and weight (sheet 1)	P 213.110.1	183	May
Heating, dressing, and hardening cable-tool drill bits	P 424.221.	215	Oct.
Conversion table for mud weights	P 425.218.41	125	Feb.
Weight of dry material added to drilling mud, lb. per gal. (Sp. Gr. of additive 2.70)	P 425.218.43	179	Mar.
Weight of dry material added to drilling mud, lb. per gal. (Sp. Gr. of additive 3.00)	P 425.218.43	113	Apr.
Weight of dry material added to drilling mud, lb. per gal. (Sp. Gr. of additive 3.50)	P 425.218.43	177	May
Drilled hole survey data per 100 ft. of hole (sheet 1)	P 429.200.1	171	Mar.
Drilled hole survey data per 100 ft. of depth (sheet 2)	P 429.200.1	101	Apr.
Area of horizontal drift—directional drilling	P 429.200.2	179	May
Wall surface area and volume of reamed hole	P 434.000.	129	Feb.
Weight of dry material added to drilling mud, lb. per gal. (Sp. Gr. of additive 2.35)	P 444.200.	113	Dec.
Weight of dry material added to drilling mud, lb. per gal. (Sp. Gr. of additive 2.50)	P 444.201.	107	Jan.
Theoretical volume of gravel required around liners in cu. ft. per ft. of length	P 459.300.	117	Dec.
Rise in fluid level, etc., due to running 1½-in. non-upset tubing in well fluid	P 511.141.150.2	91	July
Rise in fluid level, etc., due to running 2-in. non-upset tubing in well fluid	P 511.141.202.	105	Sept.
Rise in fluid level, etc., due to running 2½-in. external-upset tubing in well fluid	P 511.141.250.1	89	Aug.
Rise in fluid level, etc., due to running 2½-in. non-upset tubing in well fluid	P 511.141.252.	107	Sept.
Rise in fluid level, etc., due to running 3-in. external-upset tubing in well fluid	P 511.141.301.	219	Oct.
Rise in fluid level, etc., due to running 3-in. non-upset tubing in well fluid	P 511.141.302.	213	Oct.
Rise in fluid level, etc., due to running 3½-in. external-upset tubing in well fluid	P 511.141.351.	133	Nov.
Rise in fluid level, etc., due to running 3½-in. non-upset tubing in well fluid	P 511.141.352.	115	Dec.
Rise in fluid level, etc., due to running 4-in. external-upset tubing in well fluid	P 511.141.401.	111	Jan.
Rise in fluid level, etc., due to running 4-in. non-upset tubing in well fluid	P 511.141.402.	169	Mar.
Velocity of flow, ft. per sec., through annulus between 1¼-in. and 4-in. tubing (sheet 5B)	P 533.300.125.2	87	Aug.
Velocity of flow, ft. per sec., through annulus between 1½-in. and 4-in. tubing	P 533.300.150.2	89	July
Velocity of flow, ft. per sec., through annulus between 2-in. and 3½-in. tubing (sheet 1B)	P 533.300.200.2	103	Sept.
Velocity of flow, ft. per sec., through annulus between 2-in. and 4-in. tubing (sheet 2A)	P 533.300.200.2	115	Sept.

Title of Table		*Index No.*	*Page*	*Issue*
Velocity of flow, ft. per sec., through annulus between 2-in. and 4-in. tubing	(sheet 2B)	P 533.300.200.2	127	Nov.
Velocity of flow, ft. per sec., through annulus between 2½-in. and 4-in. tubing	(sheet 1B)	P 533.300.250.2	207	Oct.
Gravity of dry oil in oil-water mixtures, deg. A.P.I.		P 677.410.150.1	173	Mar.
Gravity of dry oil in oil-water mixtures, deg. A.P.I.		P 677.410.200.1	127	Feb.
Gravity of dry oil in oil-water mixtures, deg. A.P.I.		P 677.410.250.1	103	Jan.
Gravity of dry oil in oil-water mixtures, deg. A.P.I.		P 677.410.300.1	211	Oct.
Gravity of dry oil in oil-water mixtures, deg. A.P.I.		P 677.410.301.	87	July
Gravity of dry oil in oil-water mixtures, deg. A.P.I.		P 677.410.350.1	91	Aug.
Gravity of dry oil in oil-water mixtures, deg. A.P.I.		P 677.410.351.	111	Sept.
Gravity of dry oil in oil-water mixtures, deg. A.P.I.		P 677.410.400.1	109	Sept.
Gravity of dry oil in oil-water mixtures, deg. A.P.I.		P 677.410.401.	209	Oct.
Gravity of dry oil in oil-water mixtures, deg. A.P.I.		P 677.410.450.1	137	Nov.
Gravity of dry oil in oil-water mixtures, deg. A.P.I.		P 677.410.451.	125	Nov.
Gravity of dry oil in oil-water mixtures, deg. A.P.I.		P 677.410.50	129	Nov.
Gravity of dry oil in oil-water mixtures, deg. A.P.I.		P 677.410.500.1	175	Mar.
Gravity of dry oil in oil-water mixtures, deg. A.P.I.		P 677.410.501.	107	Dec.
Gravity of dry oil in oil-water mixtures, deg. A.P.I.		P 677.410.55	111	Dec.
Gravity of dry oil in oil-water mixtures, deg. A.P.I.		P 677.410.551.	99	Jan.
Gravity of dry oil in oil-water mixtures, deg. A.P.I.		P 677.410.550.1	107	Apr.
Base temperature multipliers, 60 deg. F. Abs.		P 680.1	123	Feb.
Pressure extensions—orifice meter calculations	(sheet 10)	P 683.32	113	Sept.
Pressure extensions—orifice meter calculations	(sheet 11)	P 683.32	217	Oct.
Pressure extensions—orifice meter calculations	(sheet 12)	P 683.32	109	Jan.
Pressure extensions—orifice meter calculations	(sheet 13)	P 683.32	121	Feb.
Pressure extensions—orifice meter calculations	(sheet 14)	P 683.32	177	Mar.
Pressure extensions—orifice meter calculations	(sheet 15)	P 683.32	109	Apr.
Pressure extensions—orifice meter calculations	(sheet 16)	P 683.32	173	May
Corresponding differentials—equal flows		P 683.320.1	105	Apr.
Corresponding differentials—equal flows	(sheet 2)	P 683.320.1	181	May
Static pressures, lb. per sq. in. abs., corresponding to L-10 chart readings		P 683.33	135	Nov.
Saponification numbers—oils containing more than 30% fatty oils—Method A	(sheet 7)	P 747.501.11	181	Mar.
Physical constants of hydrocarbons and other compounds associated with natural gas		P 771.001.	175	May

*This index will be revised monthly. The index for installments 1-12, inclusive, will be found in the May, 1938, issue; 13-24, inclusive, in the June, 1939, issue; 25-36, inclusive, in the June, 1940, issue, and 37-48, inclusive, in the June, 1941, issue.

INDEX TO ADVERTISERS IN TABLES

		Page	*Issue*	*Backing Table No.*
Air Reduction Company, Inc.		112	Sept.	P 677.410.351.
Air Reduction Company, Inc.		112	Dec.	P 677.410.55
Air Reduction Company, Inc.		112	Apr.	P 061.001.3
American Air Filter Co., Inc.		136	Nov.	P 683.33
American Air Filter Co., Inc.		106	Jan.	P 066.003.
American Meter Company	(sheet 11)	218	Oct.	P 683.32
American Steel & Wire Company		214	Oct.	P 511.141.302.
American Steel & Wire Company		114	Dec.	P 444.200.
Bantam Bearings Corporation		88	July	P 677.410.301.
Bantam Bearings Corporation		92	Aug.	P 677.410.350.1
Bantam Bearings Corporation	(sheet 1B)	104	Sept.	P 533.300.200.2
Bantam Bearings Corporation		220	Oct.	P 511.141.301.
Bantam Bearings Corporation	(sheet 2B)	128	Nov.	P 533.300.200.2
Bantam Bearings Corporation		120	Dec.	P 061.002.1
Bantam Bearings Corporation		100	Jan.	P 677.410.551.
Bantam Bearings Corporation		130	Feb.	P 434.000.
Bantam Bearings Corporation		170	Mar.	P 511.141.402.
Bantam Bearings Corporation		114	Apr.	P 425.218.43
Bantam Bearings Corporation	(sheet 16)	174	May	P 683.32
Bethlehem Steel Company	(sheet 3B)	90	July	P 533.300.150.2
Chapman Valve Manufacturing Company, The	(sheet 10)	114	Sept.	P 683.32
Chapman Valve Manufacturing Company, The		212	Oct.	P 677.410.300.1
Chapman Valve Manufacturing Company, The		116	Dec.	P 511.141.352.
Chapman Valve Manufacturing Company, The		108	Jan.	P 444.201.
Chapman Valve Manufacturing Company, The	(sheet 2)	182	May	P 683.320.1
Chiksan Tool Company		176	May	P 771.001.
Cook, C. Lee, Manufacturing Co., Inc.		176	Mar.	P 677.410.500.1
Crane Co.		128	Feb.	P 677.410.200.1
Crane Co.		106	Apr.	P 683.320.1
Foxboro Company, The	(sheet 13)	122	Feb.	P 683.32
Hazard Wire Rope Division of American Chain and Cable Co., Inc.		126	Nov.	P 677.410.451.
Hazard Wire Rope Division of American Chain and Cable Co., Inc.		126	Feb.	P 425.218.41
Hyatt Bearings Division, General Motors Sales Corporation		92	July	P 511.141.150.2
Hyatt Bearings Division, General Motors Sales Corporation		88	Aug.	P 533.300.125.2
Hyatt Bearings Division, General Motors Sales Corporation	(sheet 2A)	116	Sept.	P 533.300.200.2
Hyatt Bearings Division, General Motors Sales Corporation	(sheet 1B)	208	Oct.	P 533.300.250.2
Hyatt Bearings Division, General Motors Sales Corporation		138	Nov.	P 677.410.450.1
Hyatt Bearings Division, General Motors Sales Corporation		108	Dec.	P 677.410.501.
Hyatt Bearings Division, General Motors Sales Corporation		112	Jan.	P 511.141.401.
Hyatt Bearings Division, General Motors Sales Corporation	(sheet 2)	118	Feb.	P 066.002.
Hyatt Bearings Division, General Motors Sales Corporation	(sheet 7)	182	Mar.	P 747.501.11
Hyatt Bearings Division, General Motors Sales Corporation	(sheet 2)	102	Apr.	P 429.200.1
Hyatt Bearings Division, General Motors Sales Corporation		186	May	P 061.003.1
LeRoi Company		106	Sept.	P 511.141.202.
LeRoi Company		132	Nov.	P 061.001.1
LeRoi Company	(sheet 1)	102	Jan.	P 066.002.
LeRoi Company		174	Mar.	P 677.410.150.1
LeRoi Company		180	May	P 429.200.2
Lincoln Electric Company		130	Nov.	P 674.410.50
Medart Company, The		110	Sept.	P 677.410.400.1
Medart Company, The		110	Dec.	P 061.003.1
National Carbon Company, Inc.		124	Feb.	P 680.1
Reed Roller Bit Company		90	Aug.	P 511.141.250.1
Ridge Tool Company, The		120	Feb.	P 061.001.2
Ridge Tool Company, The	(sheet 1)	184	May	P 213.110.1
Skinner, M. B. Co.		210	Oct.	P 677.410.401.
Spang & Company		216	Oct.	P 424.221.
Staynew Filter Corp.	(sheet 14)	178	Mar.	P 683.32
Tank Seal Products Company		108	Apr.	P 677.410.550.1
Taylor Forge & Pipe Works	(sheet 15)	110	Apr.	P 683.32
Texaco Development Corp.		118	Dec.	P 459.300.
Vortox Manufacturing Company	(sheet 12)	110	Jan.	P 683.32
Vortox Manufacturing Company		104	Apr.	P 061.002.1
Waukesha Motor Company	(sheet 1)	172	Mar.	P 429.200.1
Whitney Chain & Manufacturing Company		108	Sept.	P 511.141.252.
Whitney Chain & Manufacturing Company		134	Nov.	P 511.141.351.
Whitney Chain & Manufacturing Company		104	Jan.	P 677.410.250.1
Whitney Chain & Manufacturing Company		180	Mar.	P 425.218.43
Whitney Chain & Manufacturing Company		178	May	P 425.218.43

Static Press.
1500-1595 lb.

PRESSURE EXTENSIONS—ORIFICE METER CALCULATIONS

Differential pressure, in. of water	Static pressure, lb. per sq. in., ga.																				
	1500	1505	1510	1515	1520	1525	1530	1535	1540	1545	1550	1555	1560	1565	1570	1575	1580	1585	1590	1595
2	55.03	55.13	55.22	55.32	55.40	55.50	55.58	55.67	55.75	55.85	55.94	56.00	56.11	56.21	56.29	56.38	56.48	56.56	56.64	56.74
4	77.84	77.98	78.10	78.24	78.36	79.50	78.62	78.74	78.86	79.00	79.12	79.22	79.36	79.50	79.62	79.74	79.88	80.00	80.12	80.26
6	95.32	95.49	95.63	95.80	95.95	96.12	96.27	96.42	96.56	96.74	96.88	97.00	97.18	97.35	97.49	97.64	97.81	97.96	98.11	98.28
8	110.1	110.3	110.4	110.6	110.8	111.0	111.2	111.3	111.5	111.7	111.9	112.0	112.2	112.4	112.6	112.8	113.0	113.1	113.3	113.5
10	123.1	123.3	123.5	123.7	123.9	124.1	124.3	124.5	124.7	124.9	125.1	125.2	125.5	125.7	125.9	126.1	126.3	126.5	126.7	126.9
12	134.8	135.1	135.3	135.5	135.7	135.9	136.2	136.4	136.6	136.8	137.0	137.2	137.4	137.7	137.9	138.1	138.4	138.6	138.8	139.0
14	145.6	145.9	146.1	146.4	146.6	146.9	147.1	147.3	147.5	147.8	148.0	148.2	148.5	148.7	149.0	149.2	149.5	149.7	149.9	150.2
16	155.7	156.0	156.2	156.5	156.7	157.0	157.2	157.5	157.7	158.0	158.2	158.4	158.7	159.0	159.2	159.5	159.8	160.0	160.2	160.5
18	165.1	165.4	165.7	166.0	166.2	166.5	166.8	167.0	167.3	167.6	167.9	168.1	168.4	168.7	168.9	169.2	169.5	169.7	170.0	170.3
20	174.1	174.4	174.6	174.9	175.2	175.5	175.8	176.1	176.3	176.6	176.9	177.1	177.4	177.8	178.0	178.3	178.6	178.9	179.1	179.5
21	178.4	178.7	179.0	179.3	179.6	179.9	180.2	180.4	180.7	181.0	181.3	181.5	181.9	182.2	182.4	182.7	183.0	183.3	183.6	183.9
22	182.5	182.9	183.1	183.5	183.8	184.1	184.4	184.6	184.9	185.3	185.5	185.8	186.1	186.4	186.7	187.0	187.3	187.6	187.9	188.2
23	186.7	187.0	187.3	187.6	187.9	188.2	188.5	188.8	189.1	189.4	189.7	189.0	190.3	190.6	190.9	191.2	191.6	191.8	192.1	192.5
24	190.7	191.0	191.3	191.6	191.9	192.3	192.6	192.9	193.2	193.5	193.8	194.0	194.4	194.7	195.0	195.3	195.7	196.0	196.3	196.6
25	194.6	194.9	195.3	195.6	195.9	196.3	196.6	196.9	197.2	197.5	197.8	198.1	198.4	198.8	199.1	199.4	199.7	200.0	200.3	200.7
26	198.5	198.8	199.1	199.5	199.8	200.1	200.4	200.7	201.1	201.4	201.7	202.0	202.3	202.7	203.0	203.3	203.6	204.0	204.3	204.6
27	202.2	202.6	202.9	203.3	203.6	203.9	204.3	204.6	204.9	205.2	205.6	205.8	206.2	206.5	206.9	207.2	207.5	207.8	208.2	208.5
28	206.0	206.3	206.7	207.0	207.3	207.7	208.0	208.3	208.7	209.0	209.4	209.6	210.0	210.4	210.7	211.0	211.4	211.7	212.0	212.4
29	209.6	210.0	210.3	210.7	211.0	211.4	211.7	212.0	212.3	212.7	213.0	213.3	213.7	214.1	214.4	214.7	215.1	215.4	215.7	216.1
30	213.2	213.5	213.9	214.3	214.6	215.0	215.3	215.6	216.0	216.3	216.7	216.9	217.3	217.7	218.0	218.4	218.8	219.1	219.4	219.8
31	216.7	217.1	217.4	217.8	218.2	218.5	218.9	219.2	219.5	219.9	220.3	220.5	220.9	221.3	221.7	221.9	222.4	222.7	223.1	223.4
32	220.2	220.6	220.9	221.3	221.6	222.0	222.4	222.7	223.0	223.5	223.8	224.1	224.5	224.9	225.2	225.5	225.9	226.3	226.6	227.0
33	223.6	224.0	224.3	224.7	225.1	225.5	225.8	226.2	226.6	226.9	227.3	227.6	228.0	228.4	228.7	229.1	229.5	229.8	230.1	230.5
34	226.9	227.4	227.7	228.1	228.5	228.9	229.2	229.6	229.9	230.3	230.7	231.0	231.4	231.8	232.1	232.5	232.9	233.2	233.6	234.0
35	230.3	230.7	231.0	231.4	231.8	232.2	232.6	232.9	233.3	233.7	234.0	234.3	234.7	235.2	235.5	235.9	236.3	236.6	237.0	237.4
36	233.2	233.9	234.3	234.7	235.1	235.5	235.9	236.2	236.6	237.0	237.4	237.7	238.1	238.5	238.9	239.2	239.6	240.0	240.4	240.8
37	236.8	237.2	237.5	238.0	238.3	238.8	239.1	239.5	239.9	240.3	240.6	240.9	241.4	241.8	242.2	242.5	243.0	243.3	243.7	244.1
38	239.9	240.3	240.7	241.1	241.5	241.9	242.3	242.7	243.0	243.5	243.8	244.2	244.6	245.0	245.4	245.8	246.2	246.6	246.9	247.4
39	243.1	243.5	243.9	244.3	244.7	245.1	245.5	245.9	246.2	246.7	247.1	247.4	247.8	248.2	248.6	249.0	249.4	249.8	250.2	250.6
40	246.2	246.6	247.0	247.4	247.8	248.3	248.6	249.0	249.4	249.8	250.2	250.5	251.0	251.4	251.8	252.2	252.6	253.0	253.4	253.8
41	249.2	249.7	250.0	250.5	250.9	251.3	251.7	252.1	252.5	252.9	253.3	253.6	254.1	254.5	254.9	255.3	255.7	256.1	256.5	257.0
42	252.2	252.7	253.1	253.5	253.9	254.4	254.8	255.2	255.5	256.0	256.4	256.7	257.2	257.6	258.0	258.4	258.9	259.2	259.6	260.1
43	255.2	255.7	256.1	256.5	256.9	257.4	257.8	258.1	258.5	259.0	259.4	259.7	260.2	260.6	261.0	261.4	261.9	262.3	262.7	263.1
44	258.2	258.6	259.0	259.5	259.9	260.3	260.7	261.1	261.5	262.0	262.4	262.7	263.2	263.7	264.1	264.5	264.9	265.3	265.7	266.2
45	261.1	261.5	261.9	262.4	172.8	263.3	263.7	264.1	264.5	265.0	265.4	265.7	266.2	266.6	267.0	267.4	267.9	268.3	268.7	269.2
46	264.0	264.4	264.8	265.3	265.7	266.2	266.6	267.0	267.4	267.9	268.3	268.6	269.1	269.6	270.0	270.4	270.9	271.3	271.7	272.2
47	266.8	267.3	267.7	268.2	268.6	269.1	269.5	269.9	270.3	270.8	271.2	271.6	272.0	272.5	272.9	273.3	273.8	274.2	274.7	275.1
48	269.6	270.1	270.5	271.0	271.4	271.9	272.3	272.8	273.2	273.7	274.1	274.4	274.9	275.4	275.8	276.2	276.7	277.1	277.5	278.0
49	272.4	272.9	273.4	273.8	274.3	274.8	275.2	275.6	276.0	276.5	276.9	277.3	277.8	278.3	278.7	279.1	279.6	280.0	280.4	280.9
50	275.2	275.7	276.1	276.6	277.0	277.5	278.0	278.4	278.8	279.3	279.7	280.1	280.6	281.1	281.5	281.9	282.4	282.8	283.3	283.8
51	277.9	278.4	278.5	279.4	279.8	280.3	280.7	281.1	281.6	282.1	282.5	282.9	283.4	283.9	284.3	284.7	285.2	285.6	286.1	286.6
52	280.7	281.2	281.6	282.1	282.5	283.0	283.5	283.9	284.3	284.8	285.3	285.6	286.1	286.6	287.1	287.5	288.0	288.4	288.9	289.4
53	283.3	283.8	284.3	284.8	285.2	285.7	286.2	286.6	287.1	287.6	287.9	288.4	288.9	289.4	289.8	290.3	290.8	291.2	291.6	292.1
54	286.0	286.5	286.9	287.5	287.9	288.4	288.8	289.3	289.7	290.2	290.7	291.1	291.6	292.1	292.5	293.0	293.5	293.9	294.4	294.9
55	288.6	289.1	289.6	290.1	290.6	291.1	291.5	292.0	292.4	292.9	294.3	293.7	294.3	294.8	295.2	295.7	296.2	296.6	297.1	297.6
56	291.2	291.8	292.2	292.7	293.2	293.7	294.2	294.6	295.1	295.6	296.0	296.4	296.9	297.4	297.9	298.3	298.9	299.3	299.8	300.3
57	293.8	294.4	294.8	295.4	295.8	296.3	296.8	297.2	297.7	298.2	298.7	299.1	299.6	300.1	300.6	301.0	301.5	203.0	302.5	303.0
58	296.4	296.9	297.4	297.9	298.4	298.9	299.4	299.8	300.3	300.8	301.3	301.7	302.2	302.7	303.2	303.6	304.2	304.6	305.1	305.6
59	298.9	299.5	299.9	300.5	300.9	301.5	301.9	302.4	302.9	303.6	303.9	304.2	304.8	305.3	305.8	306.2	306.8	307.2	307.7	308.2
60	301.5	302.0	302.5	303.0	303.5	304.0	304.5	305.0	305.3	306.0	306.4	306.8	307.4	307.9	308.4	308.8	309.4	309.8	310.3	310.8
61	304.0	304.5	305.0	305.5	306.0	306.5	307.0	307.5	308.0	308.5	309.0	309.4	310.0	310.4	310.9	311.4	311.9	312.4	312.9	313.4
62	306.5	307.0	307.5	308.0	308.5	309.1	309.5	310.0	310.5	311.0	311.5	311.9	312.4	313.0	313.5	313.9	314.5	315.0	315.4	316.0
63	308.9	309.5	309.9	310.5	311.0	311.5	312.0	312.5	313.0	313.5	314.0	314.4	314.9	315.5	316.0	316.4	317.0	317.5	318.0	318.5
64	311.4	311.9	312.4	313.0	313.4	314.0	314.5	315.0	315.4	316.0	316.5	316.9	317.4	318.0	318.5	319.0	319.5	320.0	320.5	321.0
65	313.8	314.3	314.8	315.4	315.9	316.4	316.9	317.4	317.9	318.4	318.9	319.3	319.9	320.5	320.9	321.4	322.0	322.5	323.0	323.5
66	316.2	316.8	317.2	317.8	318.3	318.9	319.4	319.8	320.3	320.9	321.4	321.8	322.4	322.9	323.4	323.9	324.5	325.0	325.4	326.0
67	318.6	319.1	319.6	320.2	320.7	321.3	321.8	322.2	322.7	323.3	323.8	324.2	324.8	325.4	325.8	326.3	326.9	327.4	327.7	328.5
68	320.9	321.5	322.0	322.6	323.1	323.7	324.2	324.6	325.1	325.7	326.2	326.6	327.2	327.8	328.3	328.8	329.3	329.8	330.3	330.9
69	323.3	323.9	324.4	325.0	325.5	326.0	326.5	327.0	327.5	328.1	328.6	329.0	329.6	330.2	330.7	331.2	331.8	332.3	332.8	333.4
70	325.6	326.2	326.7	327.3	327.8	328.4	328.9	329.4	329.9	330.5	331.0	331.4	332.0	332.6	333.1	333.6	334.2	334.7	335.2	335.8
71	327.9	328.5	329.0	329.6	330.1	330.7	331.2	331.7	332.2	332.8	333.3	333.8	334.3	334.9	335.4	335.9	336.5	337.0	337.5	338.1
72	330.2	330.8	331.3	331.9	332.4	333.0	333.5	334.1	334.6	335.2	335.7	336.1	336.8	337.3	337.8	338.3	338.9	339.4	339.9	340.5
73	332.5	333.1	333.6	334.2	334.8	335.4	335.9	336.4	336.9	337.5	338.0	338.4	339.0	339.6	340.1	340.6	341.2	341.8	342.3	342.9
74	334.8	335.4	335.9	336.5	337.0	337.6	338.1	338.7	339.2	339.8	340.3	340.7	341.3	341.9	342.4	343.0	343.6	344.1	344.6	345.2
25	337.0	337.7	338.2	338.8	339.3	339.9	340.4	340.9	341.5	342.1	342.6	343.0	343.6	344.3	344.8	345.3	345.9	346.4	346.9	347.5
76	339.3	339.9	340.4	341.0	341.6	342.2	342.7	343.2	343.8	344.4	344.9	345.3	345.9	346.5	347.1	347.6	348.2	348.7	349.2	349.9
77	341.5	342.1	342.7	343.3	343.8	344.4	344.9	345.5	345.9	346.6	347.1	347.6	348.2	348.8	349.3	349.9	350.5	351.0	351.5	352.1
78	343.7	344.4	344.9	345.5	346.0	346.7	347.2	347.7	348.2	348.9	349.4	349.8	350.5	351.1	351.6	352.1	352.8	353.3	353.8	354.4
79	345.9	346.5	347.1	347.7	348.2	348.9	349.4	349.9	350.4	351.1	351.6	352.1	352.7	353.3	353.8	354.4	355.0	355.5	356.1	356.7
80	348.1	348.7	349.3	349.9	350.4	351.0	351.6	352.1	352.6	353.3	353.8	354.3	354.9	355.5	356.1	356.6	357.2	357.8	358.3	358.9
82	352.4	353.1	353.6	354.2	354.8	355.4	355.9	356.5	357.0	357.7	358.2	358.7	359.3	359.9	360.5	361.0	361.6	362.2	362.7	363.4
84	356.7	357.3	357.9	358.5	359.1	359.7	360.3	360.8	361.4	362.0	362.6	363.0	363.7	364.3	364.9	365.4	366.1	366.6	367.1	367.8
86	360.9	361.6	362.1	362.8	363.4	364.0	364.6	365.1	365.7	366.3	366.9	367.3	367.9	368.6	369.2	369.8	370.4	370.9	361.5	372.2
88	365.1	365.8	366.3	366.9	367.5	368.2	368.8	369.3	369.9	370.5	371.1	371.6	372.2	372.9	373.5	374.0	374.7	375.2	375.8	376.5
90	369.2	369.9	370.5	371.1	371.7	372.4	372.9	373.5	370.1	374.7	375.3	375.8	376.4	377.1	377.1	378.2	378.9	379.5	380.0	380.7
92	373.3	373.9	374.6	375.2	375.8	376.5	377.1	377.6	378.2	378.9	379.4	379.9	380.6	381.2	381.8	382.4	383.1	383.7	384.3	384.9
94	377.3	378.0	378.6	379.3	379.9	380.5	381.1	381.7	382.3	382.9	383.5	384.0	384.7	385.4	385.9	386.5	387.2	387.8	388.4	389.1
96	381.3	382.0	382.6	383.3	383.9	384.6	385.2	385.7	386.3	387.0	387.6	388.1	388.8	389.5	390.1	390.6	391.3	391.9	392.5	393.1
98	385.3	385.9	386.6	387.2	387.8	388.5	389.1	389.7	390.3	391.0	391.6	392.1	392.8	393.5	394.1	394.7	395.4	395.9	396.6	397.2
100	389.2	389.9	390.5	391.2	391.8	392.5	393.1	393.7	394.3	395.0	395.6	396.1	396.8	397.5	398.1	398.7	399.4	400.0	400.6	401.3

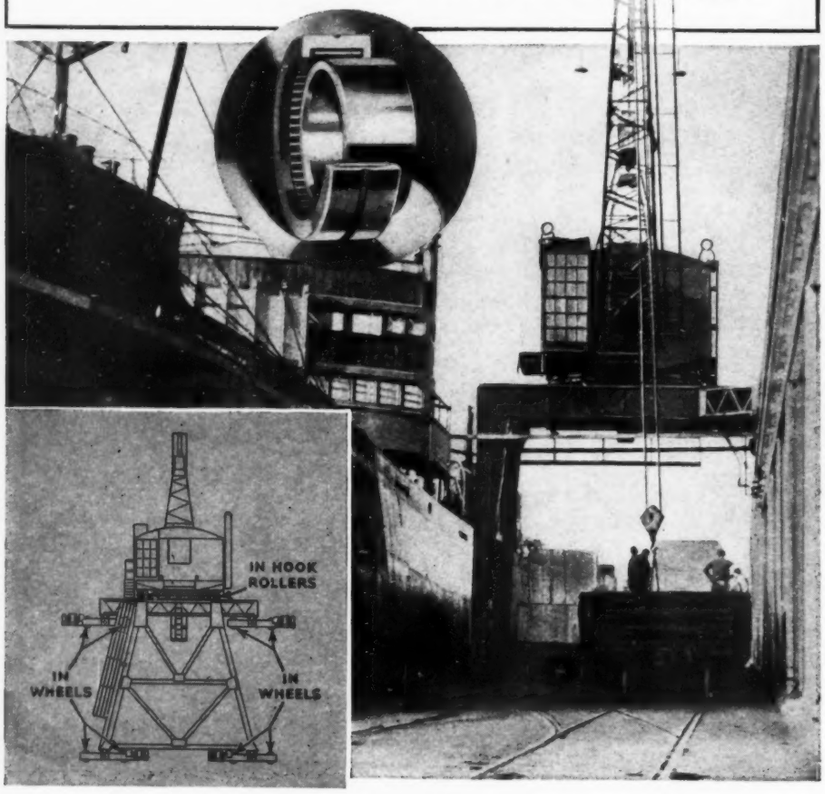
NOTE: Values given in body of table are products of the square roots of the static and differential pressures in lb. per sq. in., abs., and inches of water respectively.

Absolute pressures are based on atmospheric pressure of 15 lb. per sq. in.

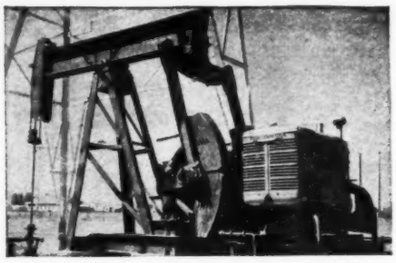
Table has been condensed to serve field men in approximating meter readings, intermediate readings for accurate measurements may be obtained from pressure extension books, usually available in district offices.

IN THE NEWS

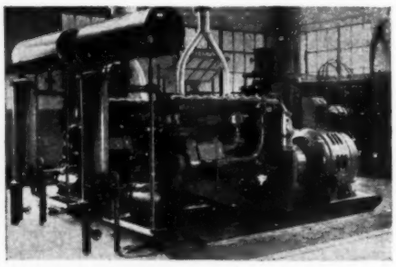
WITH BANTAM BEARINGS



SPEEDY SHIPMENT OF WAR MATERIALS is a factor of vital importance in the program of the United Nations. Supplies are quickly loaded on shipboard by this revolving gantry crane built by American Hoist & Derrick Company. Crane is equipped with three hoisting drums, one lifting 15,500 pounds at 300 feet per minute, the others with a capacity of 10,000 pounds at 270 feet per minute. 20 Bantam Quill Bearings are used on travel mechanism, as shown in drawing, and on the wire rope blocks—another instance of the ways in which Bantam Bearings are rendering efficient, reliable performance in serving every phase of the Victory program.

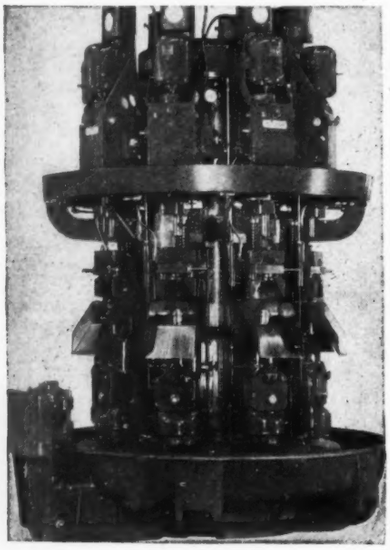


IN OIL WELL PUMPING UNITS, Bantam Quill Bearings are used by leading manufacturers to assure quiet, efficient operation, long service life, minimum need of attention. Cabot Shops, Inc., installs these compact, high-capacity units on equalizer and center bearings of its larger pumpers, obtains the advantages of anti-friction construction throughout.



ECONOMICAL POWER GENERATION is assured by modern engine and generator design. Developing 115 KW each in continuous 24-hour operation, these two generating units are powered by Murphy Diesel Company's 215 HP engines, with Bantam Quill Bearings in the generator drive assembly. For further information on these low-cost, high-capacity bearings, write for Bulletin P-104.

BANTAM'S ENGINEERING COOPERATION is especially valuable in meeting new and unusual requirements. Bantam makes every major type of anti-friction bearing—straight roller, tapered roller, needle and ball. Bantam engineers aid in the selection of the type that best suits your application—or design special bearings that meet your requirements. If you have a difficult bearing problem, TURN TO BANTAM.



SPEED AND ACCURACY are essential in machine tool operation—and Bantam's broad experience in bearing design and manufacture contributes to both these qualities. In this eight-station continuous drilling machine built by The Foote-Burt Company, the entire column rotates on a Bantam Ball Thrust Bearing measuring 27" O.D. by 22" I.D. Here is a typical example of Bantam's skill in the design of large bearings for heavy-duty applications.

BANTAM BEARINGS
STRAIGHT ROLLER · TAPERED ROLLER · NEEDLE · BALL
BANTAM BEARINGS CORPORATION • SOUTH BEND • INDIANA

PHYSICAL CONSTANTS OF HYDROCARBONS AND OTHER COMPOUNDS ASSOCIATED WITH NATURAL GAS

	Methane	Ethane	Propane	*iso*-butane	*n*-butane	*iso*-pentane	*n*-pentane	*n*-hexane	*n*-heptane	Carbon dioxide	Nitrogen	Oxygen	Air	Hydrogen sulphide	Water
Atomic formula	CH_4	C_2H_6	C_3H_8	C_4H_{10}	C_4H_{10}	C_5H_{12}	C_5H_{12}	C_6H_{14}	C_7H_{16}	CO_2	N_2	O_2	.....	H_2S	H_2O
Molecular weight	16.042	30.068	44.094	58.120	58.120	72.146	72.146	86.172	100.198	44.01	28.016	32.000	28.966	34.076	18.016
Boiling point—760 mm. °F	—258.5	—128.2	—43.8	+10.0	+31.1	+82.3	+97.0	+155.7	+209.1	—109.3	—320.4	—297.4	.....	—76.5	212
°C	—161.4	—89.0	—42.1	—12.2	—0.5	+27.9	+36.1	+68.7	+98.4	—78.5	—195.8	—183.0	.....	—60.3	100
Melting point—760 mm. °F	—296.5	—297.8	—305.8	—229.0	—218.2	—257.1	—201.5	—139.9	—131.4	*	—345.6	—361.1	.....	—121.9	+32
°C	—182.5	—183.2	—187.7	—145.0	—139.0	—160.6	—129.7	—95.5	—90.8	*	—209.8	—218.4	.....	—85.5	0.0
Critical temperature °R	343.1	549.7	665.8	732.8	765.2	829.6	846.5	914.2	972.2	547.6	226.8	277.7	238.3	672.3	1165.0
°K	190.6	305.4	369.9	407.1	425.1	460.9	470.3	507.9	540.1	304.2	126.0	154.3	132.4	373.5	647.2
°F	—116.5	+90.1	206.2	273.2	305.6	370.0	387.0	454.6	512.6	88.0	—232.8	—181.8	—221.3	+212.7	+705.4
°C	—82.5	+32.3	96.8	134.0	152.0	187.8	197.2	234.8	267.0	31.1	—147.1	—118.8	—140.7	+100.4	+374.1
Critical pressure															
Atmospheres	45.8	48.2	42.0	35.2	37.5	32.8	33.0	29.5	27.0	73.0	33.5	49.7	37.2	88.9	218.2
Lb. per sq. in. abs	673	708	617	517	551	482	485	434	397	1073	492	730	547	1306	3206.2
Critical volume															
Ml. per gm. mol	99.0	148.0	195.0	249.0	258.0	307.6	310.9	367.2	427.0	95.6	90.1	74.4	93.4	.....	56.6
Cu. ft. per lb. mol	1.586	2.371	3.123	3.990	4.130	4.930	4.98	5.88	6.84	1.532	1.443	1.192	1.496	.....	0.906
Critical density, lb. per gal	1.351	1.695	1.888	1.946	1.891	1.955	1.935	1.958	1.957	3.839	2.596	3.589	2.588	.....	2.658
Liquid density data															
Specific gravity 60°/60°F	0.3	0.4	0.509	0.564	0.584	0.625	0.631	0.664	0.688	.....	.....	.....	.....	0.79	1.000
°A.P.I. at 60°F	340.0	222.0	146.5	119.4	110.8	94.9	92.7	81.6	74.2	.....	.....	.....	.....	47.6	10.0
Density, lb. per gal. at 60°F. (wt. in air)	2.5	3.3	4.23	4.69	4.86	5.20	5.25	5.53	5.73	.....	.....	.....	.....	6.58	8.327
Vapor density data (760 mm., 60°F															
Specific gravity (perfect gas) (air = 1.00)	0.554	1.038	1.522	2.006	2.006	2.491	2.491	2.975	3.459	1.519	0.967	1.105	1.000	1.176	0.622
Density (perfect gas)															
Cu. ft. per lb.**	23.66	12.62	8.61	6.53	6.53	5.26	5.26	4.40	3.79	8.62	13.54	11.86	13.10	11.14	21.06
Lb. per 1000 cu. ft.***	42.27	79.23	116.2	153.2	153.2	190.1	190.1	227.1	264.0	116.0	73.83	84.32	76.33	89.80	47.48
Cu. ft. vapor per gal. liquid (perfect gas)**	59.17	42.09	36.52	30.70	31.79	27.41	27.67	24.38	21.72	.....	.....	.....	.....	73.35	175.62
Gal. liquid per 1000 cu. ft. vap. (perfect gas)***	16.90	23.76	27.38	32.57	31.45	36.48	36.14	41.02	46.03	.....	.....	.....	.....	13.63	5.69
Ratio, gas volume per liquid volume (perfect gas)	442.6	314.8	273.2	229.7	237.8	205.0	207.0	182.4	162.5	.....	.....	.....	.....	548.7	1313.7
Deviation factor—(760 mm. 60°F.)	1.0020	1.008	1.016	1.030	1.032	1.045	1.048	1.066	1.087	1.0058	1.00030	1.00075	1.00039	1.011	1.0012
															13.25 mm.
100°F	1.0015	1.007	1.013	1.025	1.027	1.040	1.043	1.056	1.071	1.0047	1.00012	1.00052	1.00020	.....	1.0026
															49.1 mm.
Gross heat of combustion															
B.t.u. per lb. vapor	23,916	22,350	21,692	21,288	21,338	21,058	21,121	20,970	20,859	.....	.....	.....	.....	7,479	.....
B.t.u. per cu. ft. (perfect gas) 30-in.—60°F. (dry)****	1013	1775	2526	3268	3276	4012	4025	4773	5521	.....	.....	.....	.....	673	.....
Specific heat, B.t.u. per lb. (760 mm., 60°F.)															
C_p	0.530	0.415	0.376	0.357	0.357	.....	0.347	0.339	0.335	0.199	0.248	0.218	0.241	0.254	0.458
C_v	0.405	0.346	0.324	0.312	0.312	0.309	0.309	0.305	0.302	0.153	0.176	0.155	0.171	0.192	0.343
C_p/C_v	1.309	1.198	1.161	1.144	1.144	1.121	1.121	1.113	1.109	1.304	1.404	1.401	1.410	1.32	1.335
C_p Liq	.....	.....	.....	.55 at 32	.55 at 32	.53	.64	.536	.522	.....	.....	.....	.....	.....	1.000
Heat of fusion, B.t.u. per lb.—760 mm.	25.2	40.9	34.4	.....	32.4	30.4	49.9	65.0	59.6	81.5	11.0	5.9	.....	30.0	143.4
Heat of vaporization at boiling point, B.t.u. per lb.—760 mm	249	210	183	157	165	150	151	143	137	.....	.....	.....	.....	236	971
Vapor pressure at 100°F., lb. per sq. in. abs.	.....	.....	189.5	73.5	52.0	20.3	15.5	5.0	1.63	.....	.....	.....	.....	554.6	0.949
Octane No., Motor Method. A S T M D 357-37T	100+	100+	99.5	97.0	90.5	88.7	69.3	59.0	0.0	.....	.....	.....	.....	.....	.....

*Sublimes.

**To convert to a basis of 14.73 lb. per sq. in. or 30 in. Hg multiply by 0.99769.

***To convert to a basis of 14.73 lb. per sq. in. or 30 in. Hg multiply by 1.00282.

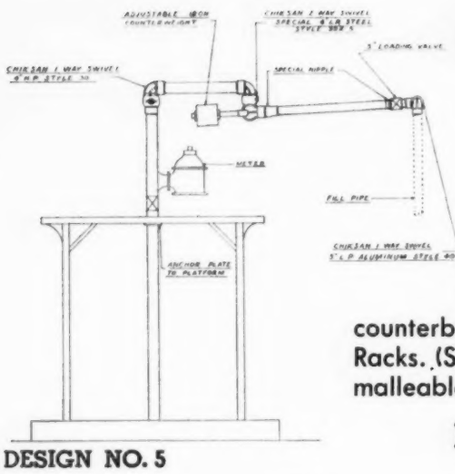
****To convert to a basis of water saturation at 60°F. multiply by 0.9825.

Note: Except where otherwise indicated, values are expressed on an "Actual" gas basis.

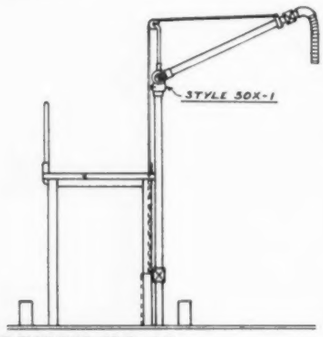
Permission to reprint table granted by copyright owner, California Natural Gasoline Association, Los Angeles, California.

CHIKSAN BALL-BEARING SWING JOINTS

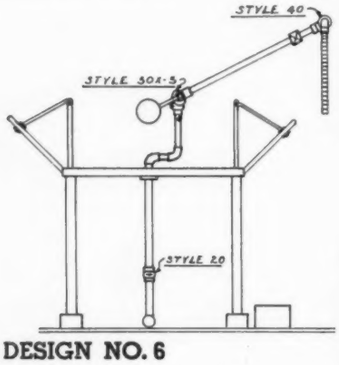
For REFINERY APPLICATIONS


ADJUSTABLE IRON COUNTERWEIGHT
CHIKSAN 2 WAY SWIVEL SPECIAL 3" I.P. STEEL STYLE 303 S
3" LOADING VALVE
CHIKSAN 1 WAY SWIVEL 4" I.P. STYLE 30
SPECIAL NIPPLE
METER
FILL PIPE
CHIKSAN 1 WAY SWIVEL 3" I.P. ALUMINUM STYLE 60
ANCHOR PLATE TO PLATFORM

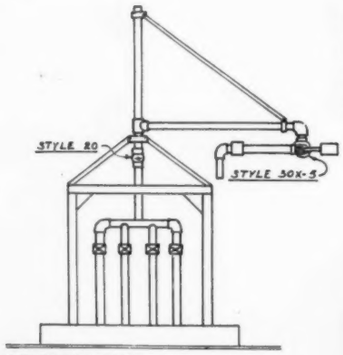
DESIGN NO. 5



DESIGN NO. 10



DESIGN NO. 6



DESIGN NO. 7

LOW PRESSURE TYPES

(To 300 Lbs. W.P.)

Supplied in eight different styles for rotation in 1, 2 and 3 planes. Sizes ⅜" to 12". Larger sizes to order. End connections are threaded, bored for welding or flanged. Various styles are provided with counterbalance connections for use on Loading Racks. (See typical diagrams at left.) Made of steel, malleable iron and bronze.

STYLE NO. 20 STYLE NO. 30
Low Pressure Type

HIGH PRESSURE TYPES

(To 3,000 Lbs. W.P.)

Supplied in eight different styles with end connections threaded or bored for welding. Flanged ends supplied on order. Full 360° rotation in 1, 2 and 3 planes. Made of steel. Sizes from ½" to 5". These High Pressure Joints are used as standard equipment in CHIKSAN All-Steel Rotary Rose.

STYLE NO. 50 x 5
Counterbalance Swing Joint

STYLE NO. 60
High Pressure Swing Joint

HIGH TEMPERATURE TYPES

(To 700° F. 500 Lbs. W.P.)

Specially designed for handling super-heated steam. Made in eight different styles for full 360° rotation in 1, 2 and 3 planes. Special Packing Set makes CHIKSAN High Temperature Swing Joints adaptable to lines handling certain materials which are injurious to rubber or synthetic compounds. Sizes from ½" to 4". Style 20 also available in ¼". Made of steel.

STYLE NO. 40
High Temperature Swing Joint

DOCK RISERS AND MARINE HOSE

(For Loading and Unloading)

CHIKSAN All-Steel Swing Joints supply the necessary flexible members for all-steel loading and unloading hose. Since these joints are both suction and pressure-tight, they may be used on both services, or in submerged lines. Flanged-end Joints serve as flexible Dock Risers which lengthen the life of fabric hose lines. When hose is worn out, these same Joints may be used in the fabrication of steel lines. Supplied in 2" to 12" sizes.

STYLE NO. 10
Flanged End Swing Joint for marine use

WRITE FOR CATALOG NO. 41

OVER 500 DIFFERENT TYPES, STYLES, SIZES

CHIKSAN TRADE MARK REG.

CHIKSAN TOOL COMPANY

BALL BEARING SWING JOINTS for ALL PURPOSES

BREA, CALIFORNIA

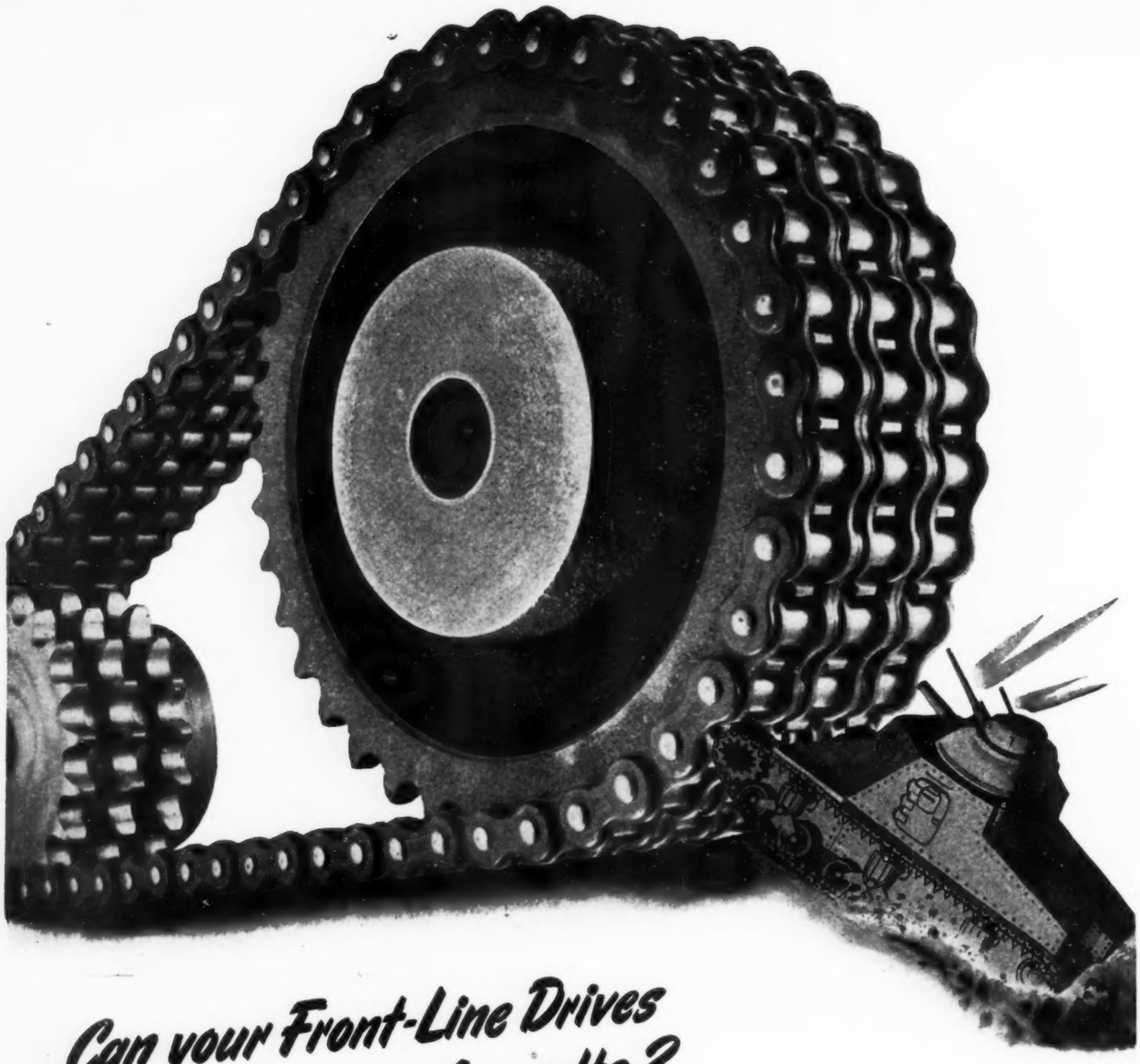
WEIGHT OF DRY MATERIAL ADDED TO DRILLING MUD, LB. PER GAL. (SP. GR. OF ADDITIVE 3.50)

Original fluid, mud or water		Desired mud weight, lb. per gal.																					
Weight, lb. per gal.	Specific gravity	9.0	9.5	10.0	10.5	11.0	11.5	12.0	12.5	13.0	13.5	14.0	14.5	15.0	15.5	16.0	16.5	17.0	17.5	18.0	18.5	19.0	19.5
		1.08	1.14	1.20	1.26	1.32	1.38	1.44	1.50	1.56	1.62	1.68	1.74	1.80	1.86	1.92	1.98	2.04	2.10	2.16	2.22	2.28	2.34
*8.345	1.00	0.97	1.73	2.54	3.39	4.29	5.23	6.24	7.30	8.42	9.59	10.9	12.3	13.8	15.3	17.0	18.8	20.8	22.9	25.3	27.9	30.6	33.7
9.0	1.08		0.74	1.53	2.34	3.21	4.13	5.10	6.13	7.22	8.42	9.59	10.9	12.3	13.8	15.5	17.3	19.2	21.3	23.5	26.0	28.7	31.8
9.5	1.14			0.76	1.57	2.41	3.30	4.25	5.25	6.32	7.46	8.67	9.92	11.3	12.8	14.4	16.1	18.0	20.0	22.2	24.6	27.3	30.2
10.0	1.20				0.78	1.61	2.48	3.40	4.38	5.41	6.52	7.70	8.92	10.3	11.8	13.3	15.0	16.8	18.8	20.9	23.3	25.9	28.7
10.5	1.26					0.80	1.65	2.55	3.50	4.51	5.59	6.74	7.96	9.26	10.7	12.2	13.8	15.6	17.5	19.6	21.9	24.4	27.2
11.0	1.32						0.83	1.70	2.63	3.61	4.66	5.77	6.96	8.24	9.59	11.1	12.7	14.4	16.3	18.3	20.5	22.9	25.7
11.5	1.38							0.85	1.75	2.71	3.73	4.81	5.97	7.21	8.51	10.0	11.5	13.2	15.0	17.0	19.2	21.5	24.2
12.0	1.44								0.88	1.80	2.79	3.85	4.98	6.18	7.47	8.84	10.3	12.0	13.8	15.7	17.8	20.1	22.7
12.5	1.50									0.90	1.86	2.89	3.98	5.15	6.41	7.76	9.26	10.8	12.5	14.3	16.4	18.7	21.1
13.0	1.56										0.93	1.93	2.99	4.12	5.34	6.65	8.06	9.59	11.3	13.1	15.0	17.3	19.6
13.5	1.62											0.96	1.99	3.09	4.28	5.55	6.91	8.42	10.0	11.8	13.7	15.8	18.1
14.0	1.68												0.99	2.06	3.20	4.44	5.76	7.20	8.76	10.4	12.3	14.3	16.6
14.5	1.74													1.03	2.14	3.33	4.61	6.00	7.51	9.17	10.9	12.9	15.1
15.0	1.80														1.07	2.22	3.45	4.80	6.26	7.84	9.59	11.5	13.6
15.5	1.86															1.11	2.30	3.60	5.00	6.54	8.21	10.0	12.1
16.0	1.92																1.15	2.40	3.75	5.23	6.84	8.59	10.6
16.5	1.98																	1.20	2.50	3.92	5.47	7.18	9.09
17.0	2.04																		1.25	2.61	4.10	5.76	7.55
17.5	2.10																			1.31	2.74	4.30	6.04
18.0	2.16																				1.37	2.87	4.53
18.5	2.22																					1.43	3.02
19.0	2.28																						1.51

Note: The body of this table supplies the weight in lb. of the dry solid to be added per gal. to drilling fluid of known weight to obtain a mud of higher weight. The above table was calculated with an additive of specific gravity of 3.50.

To use table find weight of original mud in left-hand column and desired mud weight in top line. Multiply figure from body of table by the volume of mud in gal. in well or mud pit to obtain the total amount in lb. of dry material to be added to obtain the desired mud weight.

*Water.



Can your Front-Line Drives Stand Shock-Assaults?

In today's battle for production, the sudden assaults of shock loads are more frequent. But Whitney Roller Chains have the "Stonewall" quality of ample overload capacity that takes the heaviest attacks, throws them off and keeps on going. This is the No. 1 requirement for any chain drive now that all transmission equipment must be "made to do" longer than ever. And Whitney Chains are more than just "made to do" . . . they are made to last, and to deliver full power unfailingly, under the toughest going. You can bank on Whitney design and the extra strength of Whitney alloy-armored steels to keep your production geared up to top levels for the duration. See your nearest Whitney distributor.

Protect Chain Life

Keep sprockets aligned . . . chains properly lubricated. And inspect your drives regularly to get maximum chain life.

The Whitney Chain & Manufacturing Co., Hartford, Connecticut

WHITNEY CHAINS

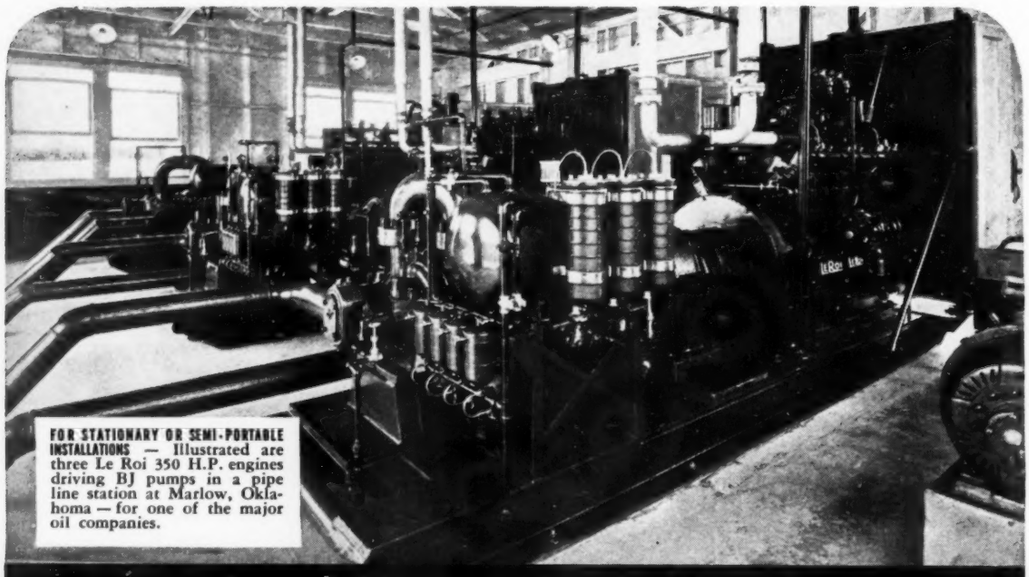
Mid-Continent Sales and Service: *Bull-Stewart Equipment Co., 5219 Grand Ave., Dallas, Texas; Brance-Krachy Co., Inc., 4411 Navigation Blvd., Houston, Texas; Weiss Chain & Transmission Co., 224 East Third St., Tulsa, Okla.; A. D. Guggenheim Co., 227 West 7th Street, Amarillo, Texas; Warford Distributing Co., 319 So. Topeka Ave., Wichita, Kansas; Prager, Inc., 472 Howard Ave., New Orleans, La.*

Mid-Continent Branch Office: *The Whitney Chain & Mfg. Co., 2826 Elm Street, Dallas, Texas.*

West Coast: *Edward D. Maltby Co., 1718 So. Flower St., Los Angeles, Calif.*

AREA OF HORIZONTAL DRIFT—DIRECTIONAL DRILLING

Depth of well in ft.	Drift angle	Horizontal drift or radius in ft.	Circular area in acres	True depth	Depth of well in ft.	Drift angle	Horizontal drift or radius in ft.	Circular area in acres	True depth
500	1°	8.73		499.9	5000	1°	87.25	0.55	4999.3
	2°	17.45		499.7		2°	174.50	2.20	4996.9
	3°	26.17		499.3		3°	261.70	4.94	4993.2
	4°	34.88		498.8		4°	348.80	8.77	4987.8
	5°	43.58		498.1		5°	435.80	13.70	4980.9
	6°	52.27		497.3		6°	522.65	19.70	4972.7
1000	1°	17.45	0.02	999.8	5500	1°	95.98	0.66	5499.2
	2°	34.90	0.09	999.4		2°	191.95	2.66	5496.6
	3°	52.34	0.20	998.6		3°	287.87	5.98	5492.5
	4°	69.76	0.35	997.6		4°	383.68	10.60	5486.6
	5°	87.16	0.55	996.2		5°	479.38	16.58	5479.0
	6°	104.53	0.79	994.5		6°	574.92	23.41	5469.9
1500	1°	26.18	0.05	1499.8	6000	1°	104.70	0.79	5999.1
	2°	52.35	0.20	1499.1		2°	209.40	3.16	5996.3
	3°	78.51	0.44	1497.9		3°	314.04	7.11	5991.8
	4°	104.64	0.79	1496.3		4°	418.56	12.64	5985.4
	5°	130.74	1.23	1494.3		5°	522.96	19.72	5977.1
	6°	156.80	1.78	1491.8		6°	627.18	28.37	5967.2
2000	1°	34.90	0.09	1999.7	6500	1°	113.42	0.92	6499.0
	2°	69.80	0.35	1998.8		2°	226.85	3.70	6496.0
	3°	104.68	0.79	1997.3		3°	340.21	8.34	6491.1
	4°	139.52	1.40	1995.1		4°	453.44	14.79	6484.1
	5°	174.32	2.19	1992.4		5°	566.54	19.23	6475.2
	6°	209.06	3.15	1989.1		6°	679.45	33.28	6464.4
	1°	43.63	0.13	2499.6	7000	1°	122.15	1.08	6998.9
2500	2°	87.25	0.55	2498.5		2°	244.30	4.30	6995.7
	3°	130.85	1.24	2496.6		3°	366.38	9.68	6990.4
	4°	174.40	2.19	2493.9		4°	488.32	17.20	6982.9
	5°	217.90	3.43	2490.5		5°	610.12	26.85	6973.3
	6°	261.32	4.93	2486.3		6°	731.71	38.61	6961.7
3000	1°	52.35	0.20	2999.5	7500	1°	130.88	1.24	7498.9
	2°	104.70	0.79	2998.2		2°	261.75	4.93	7495.5
	3°	157.02	1.78	2995.9		3°	392.55	11.11	7489.7
	4°	209.28	3.16	2996.3		4°	523.20	19.72	7481.7
	5°	261.48	4.93	2988.6		5°	653.70	30.78	7171.4
	6°	313.59	7.09	2983.6		6°	783.98	44.31	7458.9
3500	1°	61.08	0.27	3499.5	8000	1°	139.60	1.41	7998.8
	2°	122.15	1.07	3497.9		2°	279.20	5.62	7995.1
	3°	183.19	2.42	3495.2		3°	418.72	12.64	7989.0
	4°	244.16	4.29	3491.5		4°	558.08	22.46	7980.5
	5°	305.06	6.71	3486.7		5°	697.28	35.07	7969.5
	6°	365.86	9.63	3480.9		6°	836.24	50.43	7956.2
4000	1°	69.80	0.35	3999.4	8500	1°	148.33	1.59	8498.7
	2°	139.60	1.41	3997.6		2°	296.65	6.34	8494.8
	3°	209.36	3.16	3994.5		3°	444.89	14.28	8488.4
	4°	279.04	5.61	3990.2		4°	592.96	25.35	8479.3
	5°	348.64	8.75	3984.8		5°	740.86	39.58	8467.6
	6°	418.12	12.61	3978.1		6°	888.51	72.41	8453.5
4500	1°	78.53	0.44	4499.3	9000	1°	157.05	1.78	8998.7
	2°	157.05	1.78	4497.3		2°	314.10	7.12	8994.5
	3°	235.53	4.00	4493.8		3°	471.06	16.00	8987.7
	4°	313.92	7.09	4489.0		4°	627.84	28.43	8978.0
	5°	392.22	11.08	4482.9		5°	784.44	44.38	8965.7
	6°	470.38	15.99	4475.4		6°	970.77	63.83	8950.8



FOR STATIONARY OR SEMI-PORTABLE INSTALLATIONS — Illustrated are three Le Roi 350 H.P. engines driving BJ pumps in a pipe line station at Marlow, Oklahoma — for one of the major oil companies.

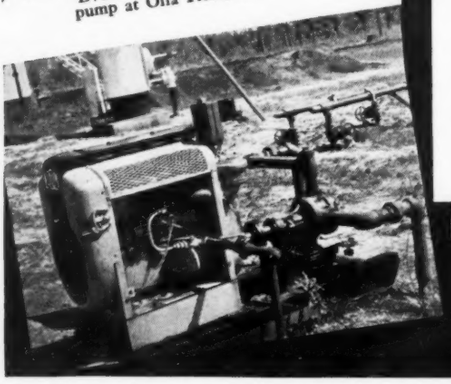
On dependable power for Pipe Line Pumps

you're "low with LEROI*"*

all the way — — —

FOR GATHERING SERVICE — *(above)* A LeRoi D201 engine operating a reciprocating pump on the property of a major oil company at Cromwell, Oklahoma.

FOR PICK-UP AND TRANSFER SERVICE — *(below)* A LeRoi D71 air-cooled engine operating a rotary pump at Olla Field, La.



- **low first cost**
- **low installation cost**
- **low operating cost**
- **low maintenance cost**

- 4 to 100 H.P. engines for gathering and pick-up pumps.
- 100 to 400 H.P. sizes for main line, standby, or emergency service — capable of handling 12,000 to 35,000 barrels per day.
- Operate on gasoline, natural gas, or butane.
- Engine and pump may be assembled as single unit.
- Compact, stationary unit with portable features — involving minimum expense and loss of time in transferring from one station to another. P-9

Equip with LeRoi — as many leaders do — and enjoy the extra margin of economy, the extra reserve of power that LeRoi engineering gives you. Write, stating size of engine in which you are interested, and we will send bulletins giving complete details.

LE ROI COMPANY • MILWAUKEE, WIS. • TULSA, OKLA.
GENERAL MACHINE & SUPPLY COMPANY
Wichita Falls — Odessa, Texas
SOUTHERN ENGINE & PUMP COMPANY
Houston — Dallas — Kilgore, Texas
WESTERN MACHINERY COMPANY
St. Louis, Missouri • Salem, Illinois

CORRESPONDING DIFFERENTIALS—EQUAL FLOWS

FOR 10-IN. FLANGES—Size of orifice plate to be installed, in.

Size of Orifice plate in use, in.	½	1	1½	2	2½	3	3½	4	4½	5	5½	6	6½	7
½	1.0	0.06	0.01											
1	16.0	1.0	0.20	0.06	0.03	0.01								
1½	81.0	5.1	1.0	0.32	0.13	0.06	0.03	0.02	0.01					
2		16.0	3.2	1.0	0.41	0.20	0.11	0.06	0.04	0.02				
2½		39.0	7.7	2.4	1.0	0.48	0.26	0.15	0.09	0.06	0.04	0.03		
3		81.0	16.0	5.1	2.1	1.0	0.54	0.32	0.20	0.13	0.08	0.05	0.04	
3½			30.0	9.4	3.8	1.8	1.0	0.59	0.36	0.23	0.15	0.10	0.07	0.04
4			51.0	16.0	6.6	3.2	1.7	1.0	0.62	0.40	0.26	0.17	0.11	0.08
4½			81.0	26.0	11.0	5.1	2.8	1.6	1.0	0.64	0.42	0.28	0.18	0.12
5				40.0	17.0	8.0	4.3	2.5	1.6	1.0	0.65	0.43	0.29	0.19
5½				61.0	25.0	12.0	6.6	3.9	2.4	1.5	1.0	0.66	0.44	0.30
6					38.0	18.0	10.0	5.9	3.6	2.3	1.5	1.0	0.67	0.45
6½					57.0	28.0	15.0	8.8	5.4	3.5	2.3	1.5	1.0	0.68
7						41.0	22.0	13.0	8.1	5.2	3.3	2.2	1.5	1.0

FOR 12-IN. FLANGES—Size of orifice plate to be installed, in.

Size of Orifice plate in use, in.	½	1	1½	2	2½	3	3½	4	4½	5	5½	6	6½	7	7½	8
½	1.0	0.06	0.01													
1	16.0	1.0	0.20	0.06	0.03	0.01										
1½	81.0	5.1	1.0	0.32	0.13	0.06	0.03	0.02	0.01							
2		16.0	3.2	1.0	0.41	0.20	0.11	0.06	0.04	0.03						
2½		39.0	7.7	2.4	1.0	0.48	0.26	0.15	0.10	0.06	0.04	0.03				
3		81.0	16.0	5.1	2.1	1.0	0.54	0.32	0.20	0.13	0.09	0.06	0.04	0.03		
3½			30.0	9.4	3.8	1.8	1.0	0.59	0.37	0.24	0.16	0.11	0.09	0.06	0.04	0.03
4			51.0	16.0	6.6	3.2	1.8	1.0	0.62	0.41	0.28	0.19	0.13	0.09	0.07	0.05
4½			81.0	26.0	10.0	5.1	2.7	1.6	1.0	0.66	0.44	0.31	0.21	0.15	0.11	0.08
5				39.0	16.0	7.7	4.2	2.4	1.5	1.0	0.68	0.47	0.33	0.23	0.16	0.12
5½				58.0	24.0	11.0	6.2	3.6	2.3	1.5	1.0	0.69	0.48	0.34	0.24	0.17
6				84.0	34.0	16.0	8.9	5.2	3.3	2.1	1.4	1.0	0.70	0.49	0.35	0.25
6½					49.0	24.0	13.0	7.5	4.7	3.1	2.1	1.4	1.0	0.71	0.50	0.36
7					69.0	33.0	18.0	11.0	6.6	4.3	2.9	2.0	1.4	1.0	0.71	0.51
7½						47.0	25.0	15.0	9.3	6.1	4.1	2.9	2.0	1.4	1.0	0.72
8						65.0	35.0	21.0	13.0	8.5	5.8	4.0	2.8	2.0	1.4	1.0

FOR 14-IN. FLANGES—Size of orifice plate to be installed, in.

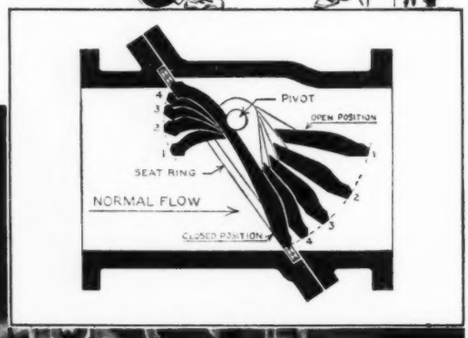
Size of Orifice plate in use, in.	2	2½	3	3½	4	4½	5	5½	6	6½	7	7½	8	8½	9	9½
2	1.0	0.41	0.20	0.11	0.06	0.04	0.02									
2½	2.4	1.0	0.48	0.26	0.15	0.10	0.06	0.04	0.03	0.02						
3	5.1	2.1	1.0	0.54	0.32	0.20	0.13	0.09	0.06	0.03	0.02					
3½	9.4	3.8	1.8	1.0	0.59	0.37	0.24	0.16	0.11	0.08	0.06	0.04	0.03	0.02		
4	16.0	6.6	3.2	1.8	1.0	0.62	0.41	0.28	0.20	0.14	0.10	0.07	0.05	0.04	0.03	
4½	26.0	10.0	5.1	2.7	1.6	1.0	0.66	0.45	0.31	0.21	0.16	0.12	0.09	0.06	0.05	0.04
5	39.0	16.0	7.7	4.2	2.4	1.5	1.0	0.68	0.47	0.34	0.25	0.18	0.13	0.10	0.07	0.05
5½	57.0	23.0	11.0	6.1	3.6	2.3	1.5	1.0	0.70	0.50	0.36	0.26	0.19	0.14	0.11	0.07
6	82.0	33.0	16.0	8.7	5.1	3.2	2.1	1.4	1.0	0.71	0.51	0.37	0.27	0.20	0.15	0.11
6½		47.0	23.0	12.0	7.2	4.5	2.9	2.0	1.4	1.0	0.72	0.53	0.39	0.28	0.21	0.16
7		65.0	31.0	17.0	9.9	6.2	4.1	2.8	1.9	1.4	1.0	0.73	0.53	0.39	0.29	0.22
7½		89.0	43.0	23.0	14.0	8.5	5.6	3.8	2.7	1.9	1.4	1.0	0.73	0.54	0.40	0.30
8			59.0	32.0	19.0	12.0	7.6	5.2	3.6	2.6	1.9	1.4	1.0	0.74	0.55	0.41
8½			79.0	43.0	25.00	16.0	10.0	7.0	4.9	3.5	2.5	1.8	1.4	1.0	0.74	0.55
9				58.0	34.0	21.0	14.0	9.5	6.6	4.7	3.4	2.5	1.8	1.3	1.0	0.75
9½				77.0	45.0	28.0	19.0	13.0	8.9	6.3	4.6	3.3	2.4	1.8	1.3	1.0

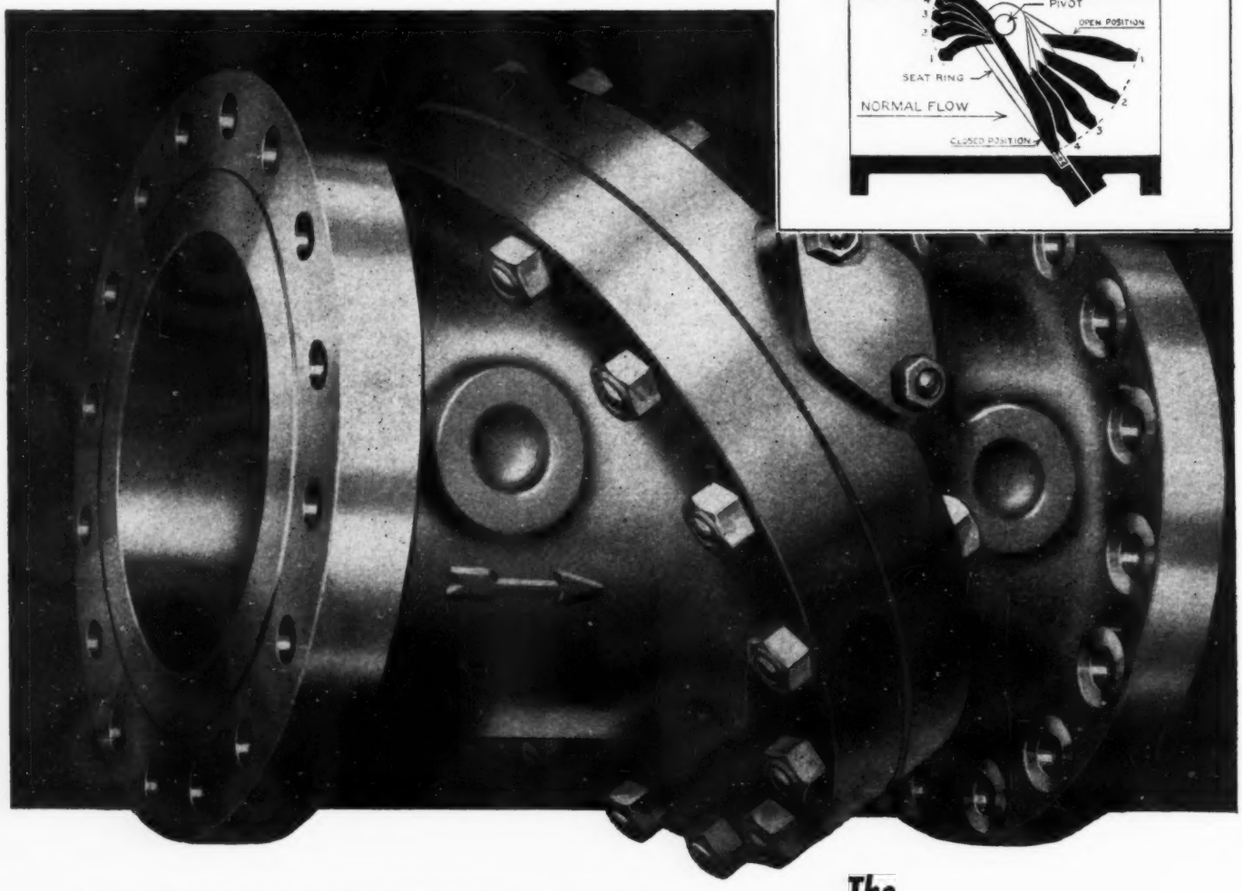
Example: The highest differential reading on a 12 in. by 6 in. orifice plate is 98 in. It is desired to install a 12 in. by 7 in. orifice plate to lower the differential. What will be the differential with the 12 in. by 7 in. orifice plate installed?

In the 12 in. flange section of the table find the 6 in. orifice size. In the column headed 7 in. at the intersection find .49. Multiply .49 by 98 in. and the new differential reading will be 48 in. on the 12 in. by 7 in. plate.

This Disc Can't Be Thrown Out of Order

...because IT NEVER SLAMS





CHAPMAN NON-SLAM CHECK VALVES are protected against wear by the tilting disc . . . of airfoil design . . . which rides steadily in the flow when the valve is open. And when flow slows, this disc is cushioned silently to a drop-tight seat. So it can't slam . . . can't set up surging or hammering in the line . . . can't open up the pipe joints. Head losses are cut as much as 80%.

Chapman Non-Slam Check Valves increase operating efficiency in refineries and on natural gas lines. They are made in iron and steel for pressures from 150 to 1500 lb. . . . with any type of end-connections . . . in a wide range of steels. Write for bulletin.

The

CHAPMAN

VALVE MANUFACTURING CO.

Indian Orchard, Mass.

EQUIVALENTS—GRAVITY, VOLUME, AND WEIGHT

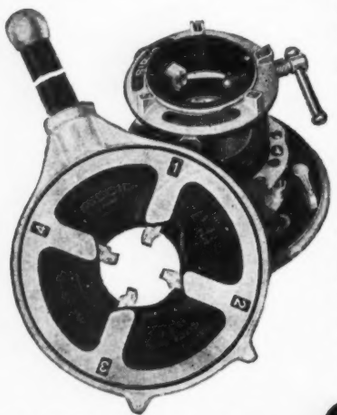
Specific Gravity	Degrees Baume	Degrees A.P.I.	lb. per gal.	lb. per cu. ft.	lb. per bbl.*	gal. per ton†	*bbl. per ton†
1.0000	10.000	10	8.337	63.367	350.2	239.9	5.71
0.9930	10.989	11	8.279	61.929	347.7	241.6	5.75
0.9861	11.979	12	8.221	61.498	345.3	243.3	5.79
0.9792	12.968	13	8.164	61.072	342.9	245.0	5.83
0.9725	13.958	14	81.08	60.652	340.5	246.7	5.87
0.9659	14.947	15	8.053	60.238	338.2	248.4	5.91
0.9593	15.936	16	7.998	59.830	335.9	250.1	5.95
0.9529	16.926	17	7.944	59.427	333.7	251.8	5.99
0.9465	17.915	18	7.891	59.029	331.4	253.5	6.03
0.9402	18.905	19	7.839	58.637	329.2	255.1	6.07
0.9340	19.894	20	7.787	58.250	327.0	256.8	6.12
0.9279	20.883	21	7.736	57.868	324.9	258.5	6.16
0.9218	21.873	22	7.685	57.491	322.8	260.2	6.20
0.9159	22.862	23	7.636	57.119	320.7	261.9	6.24
0.9100	23.852	24	7.587	56.752	318.6	263.6	6.28
0.9042	24.841	25	7.538	56.389	316.6	265.3	6.32
0.8984	25.830	26	7.490	56.031	314.6	267.0	6.36
0.8927	26.820	27	7.443	55.678	312.6	268.7	6.40
0.8871	27.809	28	7.396	55.329	310.6	270.4	6.44
0.8816	28.799	29	7.350	54.984	308.7	272.1	6.48
0.8762	29.788	30	7.305	54.643	306.8	273.8	6.52
0.8708	30.777	31	7.260	54.307	304.9	275.5	6.56
0.8654	31.767	32	7.215	53.975	303.0	277.2	6.60
0.8602	32.756	33	7.172	53.647	302.1	278.9	6.64
0.8550	33.746	34	7.128	53.323	299.4	280.6	6.68
0.8498	34.735	35	7.085	53.002	297.6	282.3	6.72
0.8448	35.724	36	7.043	52.686	295.8	284.0	6.76
0.8398	36.714	37	7.001	52.373	294.1	285.7	6.80
0.8348	37.703	38	6.960	52.064	292.3	287.4	6.84
0.8299	38.693	39	6.919	51.759	290.6	289.1	6.88
0.8251	39.682	40	6.879	51.457	288.9	290.7	6.92
0.8203	40.671	41	6.839	51.159	287.2	292.4	6.96
0.8156	41.661	42	6.800	50.864	285.6	294.1	7.00
0.8109	42.650	43	6.761	50.572	283.9	295.8	7.04
0.8063	43.640	44	6.722	50.284	282.3	297.5	7.08
0.8017	44.629	45	6.684	49.999	280.7	299.2	7.12
0.7972	45.618	46	6.646	49.718	279.1	300.9	7.16
0.7927	46.608	47	6.609	49.439	277.6	302.6	7.20
0.7883	47.597	48	6.572	49.164	276.0	304.3	7.25
0.7839	48.587	49	6.536	48.891	274.5	306.0	7.29
0.7796	49.576	50	6.500	48.622	273.0	307.7	7.33
0.7753	50.565	51	6.464	48.356	271.5	309.4	7.37
0.7711	51.555	52	6.429	48.092	270.0	311.1	7.41
0.7669	52.544	53	6.394	47.831	268.6	312.8	7.45
0.7628	53.534	54	6.360	47.574	267.1	314.5	7.49

These equivalents are at 60°F. compared with water at 60°F.
*42 gal. per bbl. †2000 lb. per ton.

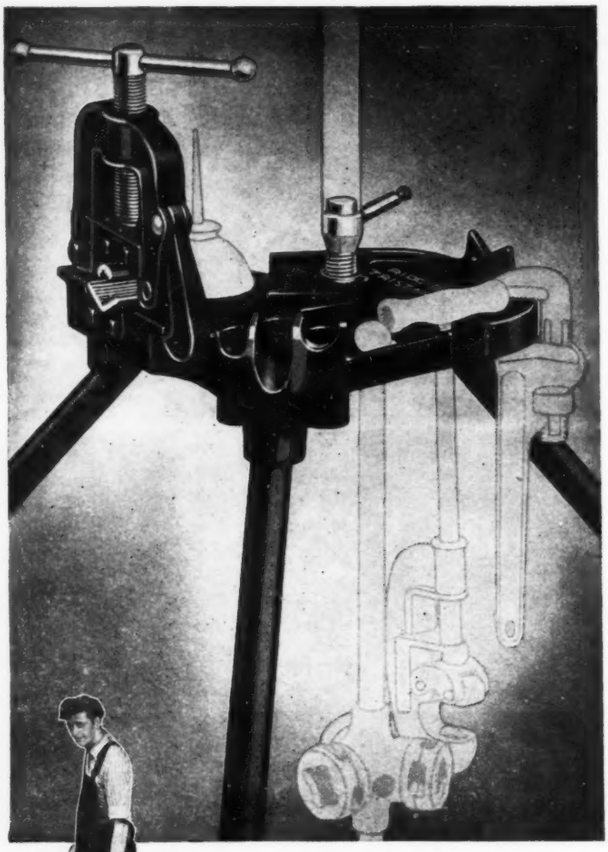
This Quicker Pipe Threading Also Speeds The Victory!

You set this RIDGID No. 65R to size in only 10 seconds . . .

It's a time-beater, a work-saver. It threads 1" to 2" pipe, 4 sizes, with 1 set of clean-cutting high speed steel chasers — no extra dies to lug around or fool with. You change size in a few seconds: screw up workholder, move setting post, screw it down again.



Speedy mistake-proof workholder sets instantly, one screw to tighten and *no bushings.* Any thread variations, any pipe — and it's made of rugged steel and malleable with drop-forged hardened steel cam plates. . . . It licks delays and waste of priceless time — ask to see it at your Supply House.



RIDGID Tri-Stand Vise

An Efficient Workbench wherever you need it

It's a war against time — make minutes count more, with this handy RIDGID Tri-Stand. Take it easily to the job — the fold-up legs quickly set up again and you have a complete workbench, plenty of room for oil cans, dope pots and slots for tools, a pipe rest and 3 benders that won't collapse pipe. Chain or yoke vise; yoke type has LonGrip jaws to protect nickel pipe. Screw down feet and ceiling brace if you want them — but it's well balanced so you don't have to baby it, and that goes for its rugged construction, too! *See it at your Supply House.*

All RIDGID Pipe Tools are sold through Supply Houses

RIDGID

THE RIDGE TOOL COMPANY
ELYRIA, OHIO, U.S.A.

Pipe Wrenches, Cutters, Threaders, Vises

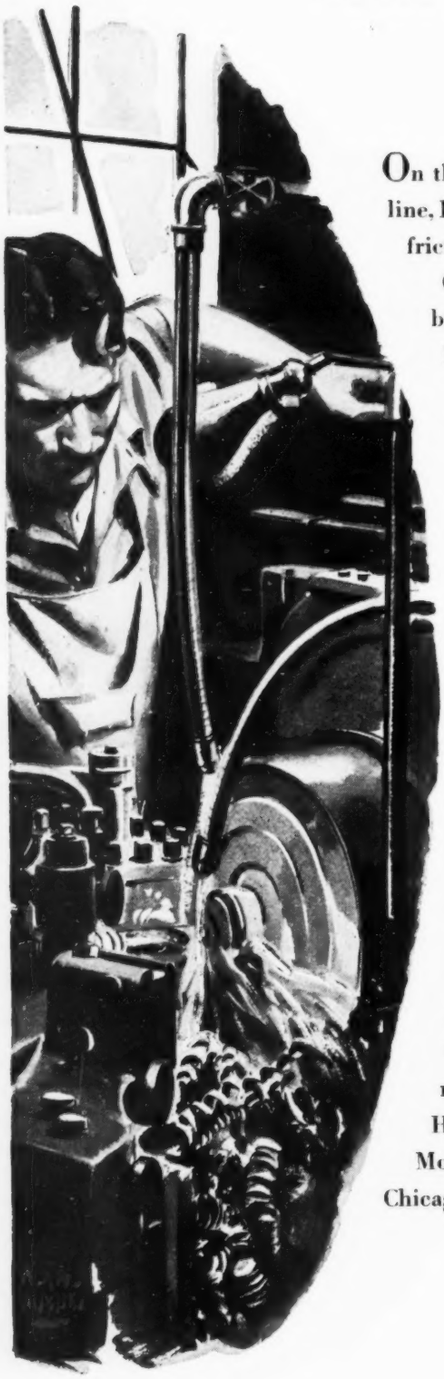
Work-Saver Tools for America's Big Job in 1942

CUBE ROOTS OF WHOLE NUMBERS

	0	1	2	3	4	5	6	7	8	9
500	7.937	7.942	7.948	7.953	7.958	7.963	7.969	7.974	7.979	7.984
510	7.990	7.995	8.000	8.005	8.010	8.016	8.021	8.026	8.031	8.036
520	8.041	8.047	8.052	8.057	8.062	8.067	8.072	8.077	8.082	8.088
530	8.093	8.098	8.103	8.108	8.113	8.118	8.123	8.128	8.133	8.138
540	8.143	8.148	8.153	8.158	8.163	8.168	8.173	8.178	8.183	8.188
550	8.193	8.198	8.203	8.208	8.213	8.218	8.223	8.228	8.233	8.238
560	8.243	8.247	8.252	8.257	8.262	8.267	8.272	8.277	8.282	8.286
570	8.291	8.296	8.301	8.306	8.311	8.316	8.320	8.325	8.330	8.335
580	8.340	8.344	8.349	8.354	8.359	8.363	8.368	8.373	8.378	8.382
590	8.387	8.392	8.397	8.401	8.406	8.411	8.416	8.420	8.425	8.430
600	8.434	8.439	8.444	8.448	8.453	8.458	8.462	8.467	8.472	8.476
610	8.481	8.486	8.490	8.495	8.499	8.504	8.509	8.513	8.518	8.522
620	8.527	8.532	8.536	8.541	8.545	8.550	8.554	8.559	8.564	8.568
630	8.573	8.577	8.582	8.586	8.591	8.595	8.600	8.604	8.609	8.613
640	8.618	8.622	8.627	8.631	8.636	8.640	8.645	8.649	8.653	8.658
650	8.662	8.667	8.671	8.676	8.680	8.685	8.689	8.693	8.698	8.702
660	8.707	8.711	8.715	8.720	8.724	8.729	8.733	8.737	8.742	8.746
670	8.750	8.755	8.759	8.763	8.768	8.772	8.776	8.781	8.785	8.789
680	8.794	8.798	8.802	8.807	8.811	8.815	8.819	8.824	8.828	8.832
690	8.837	8.841	8.845	8.849	8.854	8.858	8.862	8.866	8.871	8.875
700	8.879	8.883	8.887	8.892	8.896	8.900	8.904	8.909	8.913	8.917
710	8.921	8.925	8.929	8.934	8.938	8.942	8.946	8.950	8.955	8.959
720	8.963	8.967	8.971	8.975	8.979	8.984	8.988	8.992	8.996	9.000
730	9.004	9.008	9.012	9.016	9.021	9.025	9.029	9.033	9.037	9.041
740	9.045	9.049	9.053	9.057	9.061	9.065	9.069	9.073	9.078	9.082
750	9.086	9.090	9.094	9.098	9.102	9.106	9.110	9.114	9.118	9.122
760	9.126	9.130	9.134	9.138	9.142	9.146	9.150	9.154	9.158	9.162
770	9.166	9.170	9.174	9.178	9.182	9.185	9.189	9.193	9.197	9.201
780	9.205	9.209	9.213	9.217	9.221	9.225	9.229	9.233	9.237	9.240
790	9.244	9.248	9.252	9.256	9.260	9.264	9.268	9.272	9.275	9.279
800	9.283	9.287	9.291	9.295	9.299	9.302	9.306	9.310	9.314	9.318
810	9.322	9.326	9.329	9.333	9.337	9.341	9.345	9.348	9.352	9.356
820	9.360	9.364	9.368	9.371	9.375	9.379	9.383	9.386	9.390	9.394
830	9.398	9.402	9.405	9.409	9.413	9.417	9.420	9.424	9.428	9.432
840	9.435	9.439	9.443	9.447	9.450	9.454	9.458	9.462	9.465	9.469
850	9.473	9.476	9.480	9.484	9.488	9.491	9.495	9.499	9.502	9.506
860	9.510	9.513	9.517	9.521	9.524	9.528	9.532	9.535	9.539	9.543
870	9.546	9.550	9.554	9.557	9.561	9.565	9.568	9.572	9.576	9.579
880	9.583	9.586	9.590	9.594	9.597	9.601	9.605	9.608	9.612	9.615
890	9.619	9.622	9.626	9.630	9.633	9.637	9.641	9.644	9.648	9.651
900	9.655	9.658	9.662	9.666	9.669	9.673	9.676	9.680	9.683	9.687
910	9.691	9.694	9.698	9.701	9.705	9.708	9.712	9.715	9.719	9.722
920	9.726	9.729	9.733	9.736	9.740	9.743	9.747	9.750	9.754	9.758
930	9.761	9.764	9.768	9.771	9.775	9.778	9.782	9.785	9.789	9.792
940	9.796	9.799	9.803	9.806	9.810	9.813	9.817	9.820	9.824	9.827
950	9.830	9.834	9.837	9.841	9.844	9.848	9.851	9.855	9.858	9.861
960	9.865	9.868	9.872	9.875	9.879	9.882	9.885	9.889	9.892	9.896
970	9.899	9.902	9.906	9.909	9.913	9.916	9.919	9.923	9.926	9.930
980	9.933	9.936	9.940	9.943	9.946	9.950	9.953	9.956	9.960	9.963
990	9.967	9.970	9.973	9.977	9.980	9.983	9.987	9.990	9.993	9.997

MACHINE RUNNER and THE GUNNER

HYATTS SERVE BOTH



On the production line, as on the firing line, Hyatt Roller Bearings keep fighting friction—keep fighting for America! Correctly designed . . . precision built . . . freeing equipment from bearing wear and care . . . taking the brutal punishment of heavy loads and long hours . . . Hyatt Roller Bearings have carried on in war and peace for a half century, and will continue to serve as well in today's air, land and sea assignments.

And after industry's machines have finished their present war-time production . . . after America's guns have fired their last shots in Victory—Hyatt Roller Bearings will be serving as usual on highway and railway, in mill and factory, in farm and field—keeping things rolling quietly and economically.

Hyatt Bearings Division, General Motors Corporation, Harrison, N. J., Chicago, Detroit, Pittsburgh, San Francisco.

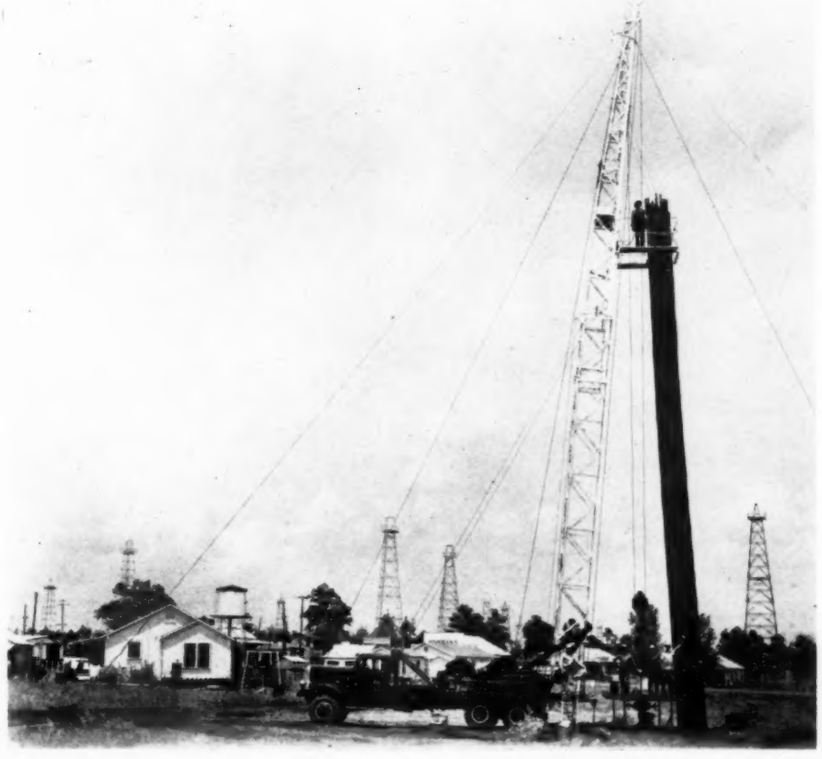
THE 50TH YEAR OF **HYATT** ROLLER BEARINGS

MACHINERY and EQUIPMENT

Welded Telescoping Mast For Oil-Well Servicing

A LARGE arc-welded mast for oil-well servicing has been designed by the Wilson Manufacturing Company, Inc., Wichita Falls, Texas, in such a manner that it will telescope almost completely, although capable of supporting about 158,000 lb.

The mast, shown in the accompanying illustration, weighs only 9000 lb. shapes. All welding was done with equipment supplied by The Lincoln Electric Company, Cleveland, Ohio.



When telescoped, the only extension on one end is the sheave. The leveling screws project on the front legs from the opposite end, reducing the overall length of the structure to 48 ft. 6 in. It may then be carried on the truck, projecting somewhat over the front at a total height above the ground of only 12 ft. 4 in.

The weight of the complete unit, including truck, well-pulling winch and mast, is about 30,000 lb. Some 8500 ft. of 2-in. upset tubing and rods, or 6500 ft. of 2½-in. tubing and rods, may be racked on the outfit.

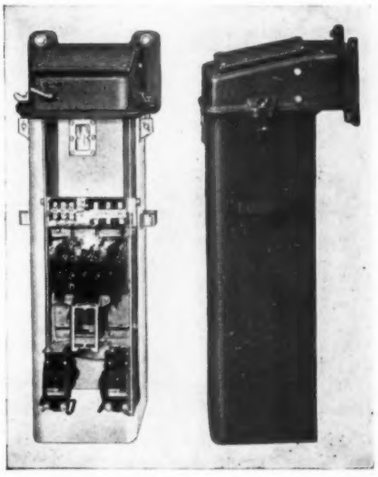
The front legs of the mast are made of 5-in. by 5-in. by ⅜-in. high tensile steel angles. The rear legs are 3-in. by 3-in. by ⅜-in. mild steel angles. All bracing and other structural parts were fabricated by arc-welding mild steel

The crown block is carried on a heavy steel box section securely welded to the main structure.

Square D Oil-Immersed Starters

GREATLY expanded activity in chemical plants, oil refineries, powder, and shell loading plants, where corrosive or explosive gases are present, have created an active demand for oil-immersed starters. The Industrial Controller Division of the Square D Company, Milwaukee, Wisconsin, is meeting this demand with a line of starters incorporating design features that are said to facilitate installation, service, and operation.

Ease of installation is provided by use of a cast head with a wiring manifold that permits conduit entrance from five directions. A removable cover plate facilitates the threading of



bare wire through an insulating spacer above the oil bath. Many problems usually encountered in servicing oil-immersed equipment have been overcome. The welded seam tank is designed for a minimum quantity of oil. A large window-type oil-level gauge provides quick, clear visibility. The drain cock is recessed in the bottom. Track-type guides prevent swinging, splashing, or accidental collision with the starter panel while the tank is being raised or lowered. Hooks at the bottom of the guide track support the tank in lowered position for inspection. All starter parts are readily accessible.

For efficient operation, the magnetic overload relays are easily adjustable to meet prevailing conditions of application. Either hand or automatic reset relays are available. Removal of the tank from a combination starter automatically throws the breaker to "off" position.

Two kinds of oil-immersed enclosure construction are available: (1) Corrosion-resisting and (2) explosion-resisting for Class I, Group D hazardous locations. Either kind can be supplied with any of the following four types of motor control equipment:

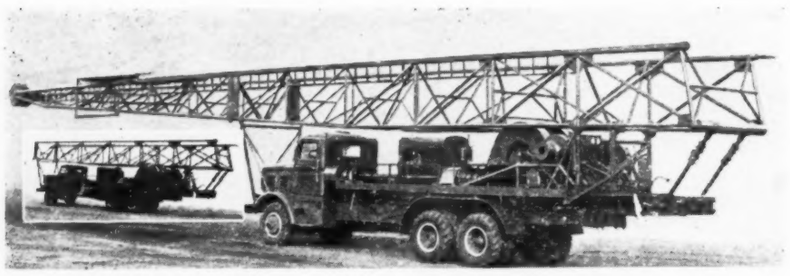
1. Class 8537 line voltage starters.
2. Class 8539 combination starters.
3. Class 8737 reversing starters.
4. Class 8810 two-speed starters.

This line of oil-immersed starters is manufactured by the Industrial Division of the Square D Company, 4041 North Richards Street, Milwaukee, Wisconsin.

Truck-Mounted Drilling Rig

THE 84-ft. derrick truck-mounted drilling rig (illustrated) is so constructed that the top section may be quickly and easily removed or attached for long-distance moves.

The rig is built to permit pulling in doubles, and may be moved over short distances with the full 84-ft. derrick folded down over the truck. Inset shows the top section removed for long moves.



The two derrick sections are fastened together in positive alignment on the ground before the derrick is raised. The joints are entirely rigid as a result of the use of self-aligning tapered plugs and bolts.

The derrick may be raised within five minutes by a patented screw-raising device driven by the power plant of the unit — no auxiliary engine, pumps, hydraulic lines, or cylinders are needed. The derrick, of open face design, has a capacity of 150,000 lb. It is of light weight and is entirely electrically welded.

The rig is arranged for three-man crew operation without reducing drilling speed or working undue hardships on the men. The 84-ft. derrick portable truck-mounted drilling rig is capable of drilling to 5000 ft. "slim-hole."

The equipment is made by the Franks Manufacturing Corporation, Tulsa, Oklahoma.

Sequence Timer for Resistance Welding

FOR use in automatic resistance spot, butt, or projection welding, a new weld and sequence timer is announced by Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pennsylvania.

Housed in a steel wall-mounted enclosure of black crinkled finish, the unit is 17¼ in. high, 12 in. wide, and 12 in. deep. Approximate shipping weight is 60 lb. On a dead front panel, also of steel, are mounted the individual timing circuit, adjusting potentiometer knobs and dials, repeat and non-repeat switches, and the tubes.

Simply turning the dials to desired setting for each period or function of the new Westinghouse timer establishes the automatic timing sequence. The controls are mounted on a hinged dead front panel that for accessibility can be opened by removing a single bolt

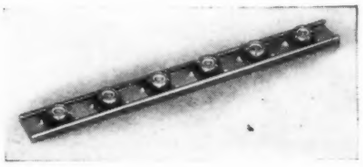
The control transformer is wound for 115/230/460/515 volts, 50/60 cycles. The solenoid relay is rated 25 amp. at 110 or 220 volts and 10 amp. at 440 or 550 volts. Standard foot switch control voltage is 115 volts except when 24-volt circuit operation is specified.

The timing circuit is fully electronic and consists essentially of a resistor capacitor circuit whose charging rate is adjustable by varying a resistor. The voltage of the circuit is applied to the grid of a thyratron tube so that after a predetermining charging time has elapsed the thyratron is energized and operates the relay.

The timer divides the total time of a weld into the various intervals in which the welder goes through its operating sequence and includes a "weld" period of 3 to 30 cycles when the full welding current flows. When welding thick plates, brass, or stainless steel, timing facilities permit intermittent heating and cooling steps of from 3 to 30 cycles.

Elastic Stop Gang Channel Nuts

ELASTIC Stop gang channel nuts, widely applied in the aircraft industry, are now offered by the Elastic Stop Nut Corporation, 2332 Vauxhall Road, Union, New Jersey, for testing on the many applications in general industry where a multiple, self-locking, bolted fastening is required. These strips of self-locking nuts have the approval of the military and civil air authorities and are used on all American-built military and transport aircraft, on fuselage and wing structures, engine cowlings, cover and inspection plates, around windows and doors, and at other points where a series of fastenings is required.



The strips are factory-assembled, and it is necessary only to rivet or otherwise fasten them to the structure where they are to be used. They consist of specially designed Elastic Stop Nuts, with four lugs at the base and installed at specified intervals in a metal channel strip that is preformed to accommodate the nut lugs under longitudinal flanges. The channel strip is pierced for the required nut size and spacing, and the nuts are held in place by dimples in the channel, tolerances permitting them to be virtually self-centering.

In application, the assembled gang channel is permanently attached to the structure with bolt holes aligned with those in the structure. As in all Elastic Stop Nuts, the locking action is obtained with a vulcanized red fiber collar that resists the entry of the bolt. This action forces the nut outward, creating a constant metal-to-metal pressure-contact throughout the threads of nut and bolt, taking up all axial play, and creating a cushion against vibration stresses and impact. The fiber locking element retains its resiliency permanently and is not subject to fatigue under the most severe conditions of vibration, the manufacturer asserts.

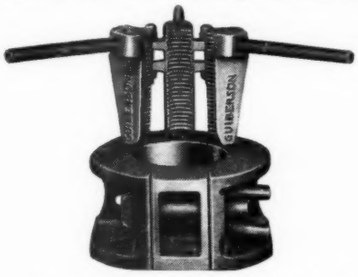
Of special advantage is the fact that, although gang channel nuts are permanently mounted to the structure, it is possible to remove or replace individual nuts should this be necessary because of damage in application or in use. A nut may be easily removed from the channel by inserting a thin screwdriver between the flange and the nut and drawing it sharply toward the flange. The nut will snap out of the channel. To replace a nut, it is placed on the channel strip so that two of the lugs are under the flange, the other two resting on the opposite flange. A sharp blow with a hammer directly on the top of the nut will snap it into

position. In neither case is it necessary to remove the channel from its permanent attachment to the structure or to disturb the remaining nuts in the unit.

Elastic Stop gang channel nuts are supplied in standard 6-ft. straight lengths in a wide variety of nut sizes, thread systems, spacing, materials, and finishes. Nut sizes range from No. 8 through ⅜-in. bolt diameters. Spacings vary from ⅝ in. to 3 in. between centers, depending upon the size of nuts and the character of the application. The nuts are supplied without countersink for regular blind mounting or countersunk for flush mounting.

Newest Guiberson Spider Offers Strength With Light Weight

THE problem of obtaining extreme light weight in a tubing spider that is still capable of carrying the heaviest loads, has recently been solved



by the Guiberson Corporation, Dallas, Texas, with its new Guiberson Type B Spider, here illustrated.

In this spider expert engineering and exhaustive tests have achieved strength that can be depended upon to carry the heaviest loads, with light weight that assures utmost handling ease, the manufacturer asserts. The weight in all tubing sizes is 130 lb. or less. Slips have cored-out backs and are extremely light and easy to handle. Their narrow backs cause them to fit the bowl true regardless of their vertical position.

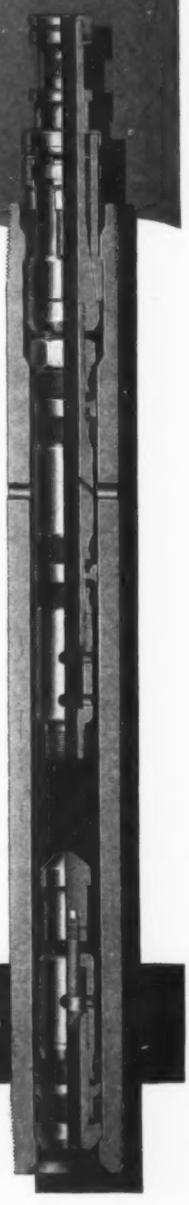
Exhaustive tests have proved the strength and dependability of this tool, it is stated. In the laboratory the bowl was supported on its outer edge and a static load of 235,000 lb., equivalent to 50,000 ft. of 2-in. upset tubing, was applied to a solid bar set in the slips. Upon examination of the spider after the test, no indication of the slightest damage could be found, it is pointed out.

To test support given the tubing by the slips, a short piece of 2½-in. tubing, J55 grade, was placed in the slips and subjected to a pull of 120,000 lb., equivalent to 20,000 ft. of 2½-in. upset tubing. Upon examination of the tubing after the test, it was found to be true and unaffected by the slips.

Don't Guess
BOTTOM HOLE
PRESSURES
IN 2 ZONE WELLS

an OTIS TYPE G (Side Door) CHOKE

MAKES POSSIBLE ACCURATE PRESSURE GAUGING OF EITHER ZONE . . .



ACCURATE knowledge of *Bottom Hole Pressure* is *necessary* for efficient production.

The OTIS Type G Choke provides a means to take Bottom Hole Pressures of either producing zone INDEPENDENTLY of the other.

The Type G landing nipple, which is made up in the tubing string, has four ½-inch holes through its walls, permitting flow from the casing annulus or upper zone into the tubing. The Removable Choke seats and locks in the landing nipple and provides complete control of the entrance of fluid into the tubing string from either or both pays.

By using a blank cup mandrel, the side ports of the landing nipple can be blanked off, permitting flow into the tubing from the lower pay only. The Bottom Hole Pressure can then be accurately taken of the lower zone.

To reverse these conditions, a perforated cup mandrel with its lower end plugged is used. This combination shuts off the lower zone, and permits the pressure to be taken from the upper pay only.

The running and pulling of the Type G Choke can be done under pressure on the same steel measuring line used to run the bottom hole pressure instruments.

The Type G Choke is a versatile tool and there are many ways it can be efficiently used in dual formations. Consult your nearest Otis representative or write direct for complete information and details.

OTIS PRESSURE CONTROL, INC.
DALLAS, TEXAS

PRESSURE CONTROL OTIS SERVICE EQUIPMENT

Branches: Houston, Texas; Hobbs, New Mexico; New Iberia, Louisiana

Representatives: Otis Eastern Service, Inc., Wellsville, New York; Western Pressure Control, Inc., Los Angeles and Bakersfield, California

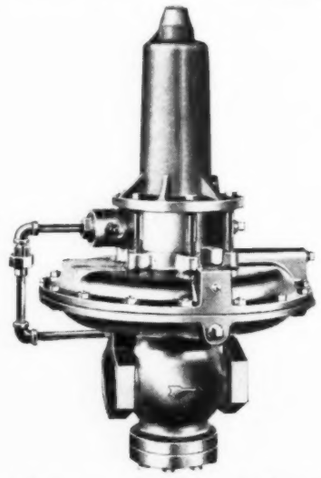
Export Office: 74 Trinity Place, New York City

Emco Announces New Regulator

THE Pittsburgh Equitable Meter Company has announced the addition of a high-pressure series to the present line of Emco "1001" Gas Pressure Regulators.

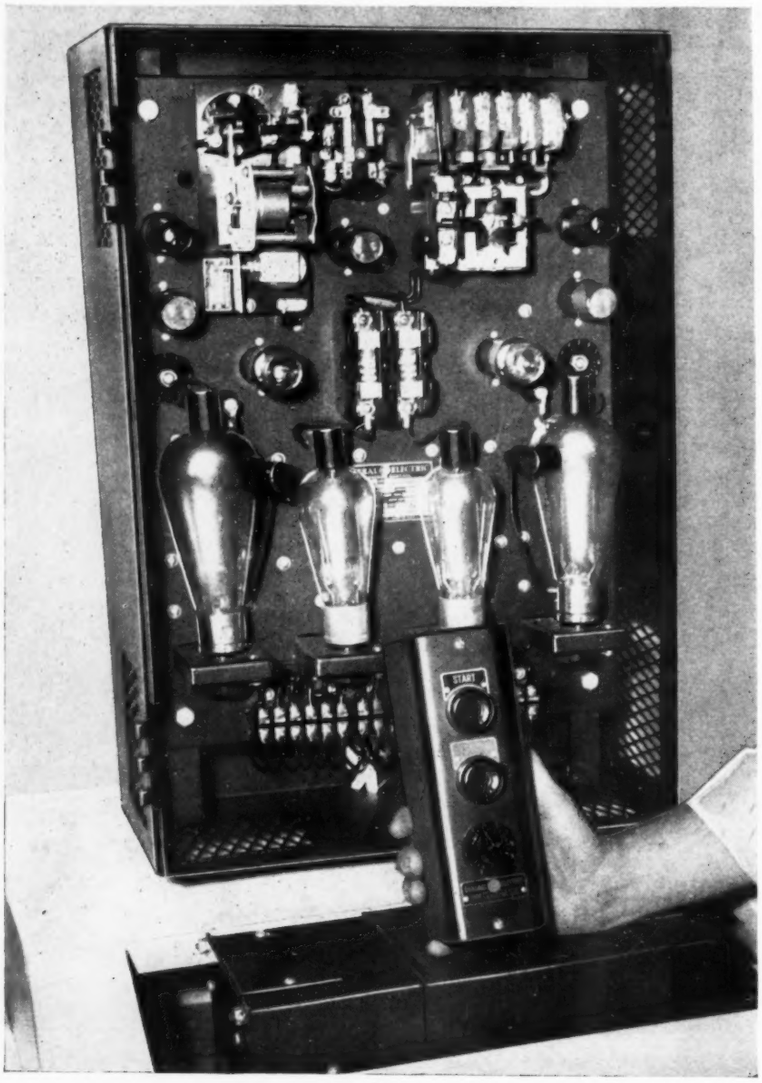
As in the standard "1001" regulator, this model is supplied either for outlet or inlet pressure control. This high-pressure series regulator, which provides an outlet pressure range as high as 60 lb. per sq. in. maximum, is designed to cover the entire span between 5 lb. and 60 lb. with the same spring.

It is supplied in one size only with 2-in. threaded connection for standard pipe. The manufacturer states that this regulator can be used to control air and manufactured or natural gas. Descriptive literature may be obtained by writing the Pittsburgh Equitable Meter Company, 400 North Lexington Avenue, Pittsburgh, Pennsylvania.



G-E Electronic Motor Control

AS an outgrowth of its thyratron speed control for d-c. motors, the General Electric Company, Schenectady, New York, has announced a new electronic control system, called Thy-mo-trol, to provide simple, stepless control of d-c. motors from a-c. lines wherever a wide speed range is needed.

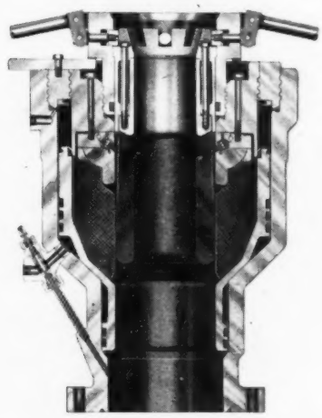


With this new development, the flexibility of d-c. motors can now be combined with the economy and convenience of a-c. power distribution. The Thy-mo-trol system leads to simplified machine design, reduced space requirements, and a saving in time over more complex methods of obtaining a wide speed range, the manufacturer asserts.

Normally consisting of three separate units—a small control station, a transformer, and thyratron tube panel—the control is the first to provide in one equipment the means for electronically starting, stopping, accelerating, and regulating the speed of a motor, it is stated. Standard units will cover motor sizes to 5 hp., 230 volts.

Auxiliary Packing Unit

AN auxiliary packing unit to protect the regular packer of the Hydril Type "R" blowout preventer from wear is announced by the Hydril Company, 714 West Olympic Boulevard, Los Angeles, California.



The principal purpose of the auxiliary packing unit is to provide a wear-absorbing member that will reduce packer rubber replacement costs and conserve rubber.

The Type "R" blowout preventer is ordinarily supplied with a rubber packing unit of approximately the same bore as its connecting flange. Rubber packing units with a smaller bore heretofore have been substituted for the regular packing unit when pipe of small size was in use.

The new auxiliary packing unit permits changes in bore diameter between

the maximum and minimum desired to be made by substituting auxiliary units of different size, the regular packing unit being used in all cases.

The auxiliary unit takes all the wear during operation of the blowout preventer and can be replaced at relatively small expense, it is stated.

The auxiliary packing unit is attached to the Type "R" blowout preventer by means of a semi-automatic locking device shown in the accompanying cross-sectional view. The locking device permits the removal and assembly of the auxiliary packing unit in the blowout preventer with minimum effort.

When the drill string includes a member larger than the bore of the auxiliary packing unit, the unit may be unlocked from its place in the blowout preventer by pulling a single lever situated on the derrick floor. The auxiliary unit then is lifted from the blowout preventer by a large-diameter tool. When the string is started in the hole again the auxiliary unit drops into place in the blowout preventer and locks automatically.

When the Type "R" blowout preventer is being used in smaller sized casing, an auxiliary packing unit with a bore approximately the same as that of the casing is used.

Sucker-Rod Protectors

A NEW type of slidable sucker-rod protector molded from a special wear-resistant material has been developed by Patterson-Ballagh Corporation, Los Angeles, California. The protector is molded directly onto the polished rod of a standard pony rod.

There is just enough clearance so that the rod will slide inside the protector instead of against the rough tubing. The rod is smooth and the protector is a plastic bearing surface. Using oil as the medium of lubrication, the unit operates as an underground polished rod.

The protectors fit pony rods, sizes $\frac{5}{8}$ to 1 in.

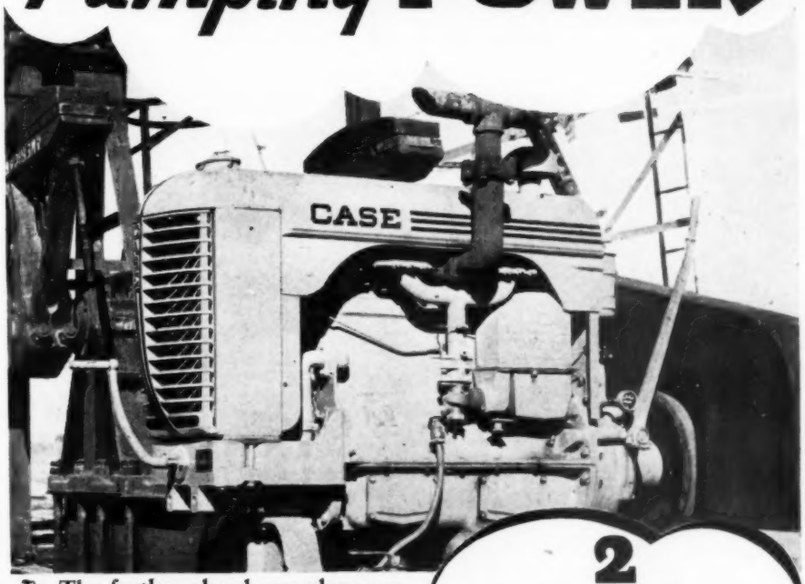
The manufacturer asserts that use of the equipment reduces pumping load, and field tests indicate that the protector solves the worn rod box and tubing problem.

Quick-Hardening Iron Cement

A NEW Smooth-On product, based on the 47 years' experience of the manufacturer in making iron repair cements, has been developed for quick patching of cracks, ruts, and shallow holes in concrete floors. This product, known as Smooth-On No. 7B Quick Patch Cement, hardens quickly and adheres firmly to the surfaces with which it is in contact.

Like other Smooth-On cements, the new composition has an iron base, so that it is extremely wear-resistant as well as dust-proof, oil-proof, and water-proof, the manufacturer states. Patches of Smooth-On No. 7B harden over-night, permitting full traffic the following morning, and become stronger with age, it is asserted. Complete information and prices can be obtained by addressing Smooth-On Manufacturing Company, Department 341, 570 Communipaw Avenue, Jersey City, New Jersey.

LONG RANGE
Pumping POWER



The farther ahead you plan your pumping program . . . the farther away you want to keep from frequent attendance . . . the farther down you must pare your operating and upkeep costs, the more you will like the endurance and self-protection built into the new 35 H.P. "DE" and 55 H.P. "LAE" Case oilfield engines.

Pressure-oiled governor and clutch, four-ring pistons, self-sealing water pumps run longer before needing attention. Automatic cut-outs act if engine temperature goes up or oil pressure goes down, guard against damage by mishap or neglect. Ask distributor for details. J. I. Case Co., Racine, Wis.

2 Brand-New Models

DISTRIBUTORS
Southwest Equipment Co.
Dallas and Kilgore, Texas
Leland Equipment Co.
Tulsa, Oklahoma

CASE
Oil Field Engines

Load-Center Unit Substation

NEW standardized load-center unit substations are now available in sizes ranging from 100 to 2000 kva., according to an announcement by the Allis-Chalmers Manufacturing Company, Milwaukee, Wisconsin. These compact, coördinated, factory-built units can be installed anywhere in industrial plants or power distribution centers, saving valuable headroom, floor space, and long secondary runs of heavy copper, it is stated.

Extremely flexible, the standard unit substations offer a wide choice of incoming—and outgoing—line arrangements. The substation consists of a metal-enclosed, incoming-line section, a throat-connected transformer, and a low-voltage feeder section.

On the high voltage side potheads, disconnect switches, oil fuse cutouts, metal-clad switchgear or direct connection through terminal box can be supplied. On the low voltage side, stationary or drawout air breakers, electrically or manually operated, are supplied. Transformers can be oil immersed, dry type, or non-inflammable Chlorextol liquid-filled.

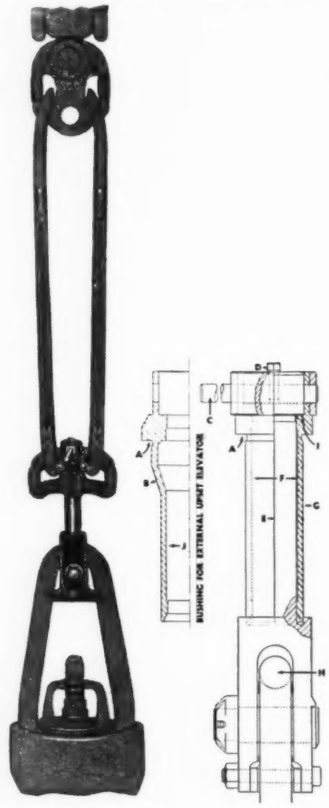
Complete enclosure, uniformity of appearance, absence of exposed leads, buses and splices—all make the load-center unit substation an attractive addition to industrial plant or power distribution center, it is pointed out by the manufacturer.

Installation of the standard unit substations is rapid and easy—the two or three component sections shipped from the factory are simply throat-connected and the power leads attached. Standard load-center unit substations are available for either indoor or outdoor service.

Drilling Hooks of New "Duplex" Design

FOR certain special uses, the well-known BJ Triplex Hooks are now supplied on order with a Duplex body, which attaches in place of the usual Triplex, or 3-hook body.

The left portion of accompanying illustration shows the Duplex body used in connection with the new BJ



Swivel Bail Adapter to provide a quick, safe means of setting the kelly and swivel into the rathole when the drilling string is going-in or coming-out of the hole, or when casing is being run. In the line drawing (with the swivel bail, H, in position) the elevator is closed under a shoulder, I, on a solid shank when small-diameter drill pipe is being used, or under the shoulder, A,

● **Union-Formed** (pre-formed) Wire Ropes end "porcupining." The wires, when worn through, lay flat to the rope, and the strand and wires stay in fabricated balance; do not develop high strands or drawn wires. **Union-Formed** ropes socket better—are more easily spliced—resist unraveling and unlaying when cut—and can be installed more easily. To keep orders moving, depend on **Union-Formed,** the better pre-formed Wire Ropes.

WRITE FOR
ROPE DOPE
This informative wire rope periodical will be sent you without charge.

UNION WIRE ROPE CORPORATION
2106 Manchester Ave. Kansas City, Mo.
Tulsa • Houston • Chicago • Salt Lake City
New Orleans • Monahans • Portland • Ashland, Ky.

UNION Wire Ropes
The ULTIMATE LOW COST WIRE ROPE"

2-42

of a bushing (split at E) when larger diameter drill pipe is in service.

By selecting the proper split bushing, each BJ Swivel Adapter will handle several drill pipe sizes; for example, when the shank diameter, F, is 3½ in. the bushing, G, can be 4½ in. and the bushing at J will handle 4½-in. external upset drill pipe.

One end of pin, C, holds the bushing retaining ring in position and the other end of this pin protrudes sufficiently to prevent rotation of the swivel in the elevator. A cap screw and lock washer, D, retain pin, C, in position.

When the bushing for external upset drill pipe is being used, the load is carried under the shoulder, A. The diameter of the bushing at, B, (being less than the bore of the elevator) serves only to center the bushing in the elevator, thus eliminating the possibility of a bending moment in the adapter.

The BJ Swivel Bail Adapter is made in sizes for handling all popular sizes of drill pipe, and complete data are available from Byron Jackson Company, Los Angeles, California, Houston, Texas, or New York, New York.

Fire-Extinguishing Compound

DUGAS ENGINEERING CORPORATION, Marinette, Wisconsin, has announced a new dry fire-extinguishing compound, duMag, a powder developed specifically for extinguishing magnesium and incendiary-bomb fires. The manufacturers say its advantages over salt or sand to be these: Takes less to extinguish the fire, it is moisture-resistant, remains free-flowing even when stored for long periods, is non-abrasive, and will not react with burning magnesium. DuMag's assorted advantage over water-spray is that duMag will extinguish quickly, whereas water-spray is used to accelerate the fire and shorten burning time.

DuMag powder is a blend of various chemicals in correct proportions to give the desired characteristics, it is stated. It can be applied directly from he container to the fire, or to the burning bomb, with scoop, shovel, extinguisher, or other mechanical means. DuMag has been tested and approved by the Factory Mutual Laboratories for fires in magnesium alloys.

DuMag is available in 45-lb. pails and in 12-lb. tubular containers. The quantity in the tube is said to have been proved by actual test to be amply sufficient to extinguish the common 2-lb. magnesium-thermit type incendiary bomb.

Static-Discharging V-Belts

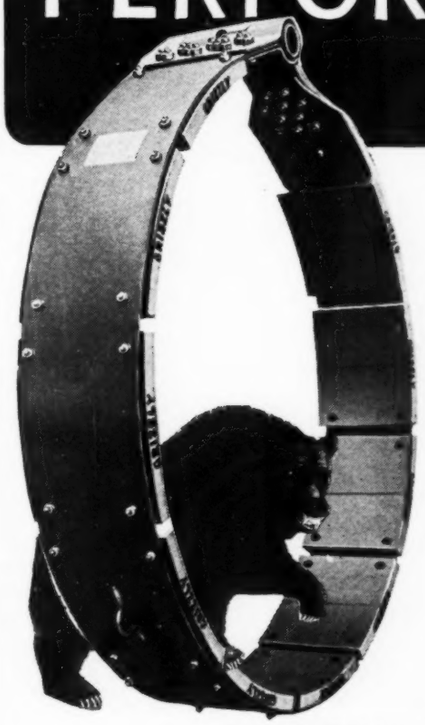
ANNOUNCEMENT is made by The B. F. Goodrich Company, Akron, Ohio, which a short time ago introduced new lines of static-discharging and oil-resistant V-belts, that these lines are now being carried in stock in all popular sizes of A, B, and C cross-sections. Previously the belts had been made only on special orders.

The static-discharging V-belt accomplishes its function through the use of a rubber in the belt covers that are so compounded as to actually conduct electricity. Static charges are not built-up because the electricity flows continuously through the belt to the sheave and out through the frame of the machine. When the machine is grounded, no possibility of sparking is present, the manufacturer asserts.

The belt cannot become a path for a short circuit because, although it permits a constant dissipation of static, it does not have sufficient conductivity to act as the bridge for a short-circuit between motor, the machine, and the operator, it is stated.

The static-discharging V-belt retains its qualities of static dissipation because these properties are built into the rubber compounds, and the belt keeps these characteristics throughout its normal life or until the covers have been worn away.

CHECK
GRIZZLY
REG U S PAT OFF
PERFORMANCE
in the field



When you want *facts* on brake block performance, check the service records of Grizzly Blocks in the field. They are doing an excellent job wherever used, in all kinds of drilling service, under all operating conditions. Their performance records provide a high standard of safety, efficiency and economy for comparison. You can't go wrong when you have the facts—so be sure. Investigate and get the facts on brake block value.

GRIZZLY MANUFACTURING CO.
Formerly E. M. Smith Co.
Plants: Los Angeles, California. Paulding, Ohio

Complete Stocks Maintained in our Warehouses At: 407 Velasco Street, Houston, Texas. 1008 S. E. 29th St., Oklahoma City, Okla. 1621 East Yellowstone, Casper, Wyo. *Export Office:* Continental Emsco Co., 30 Rockefeller Plaza, New York, N. Y.
Distributed by Leading Supply Companies

GRIZZLY
REG U S PAT OFF
ROTARY BLOCKS

Conference Held

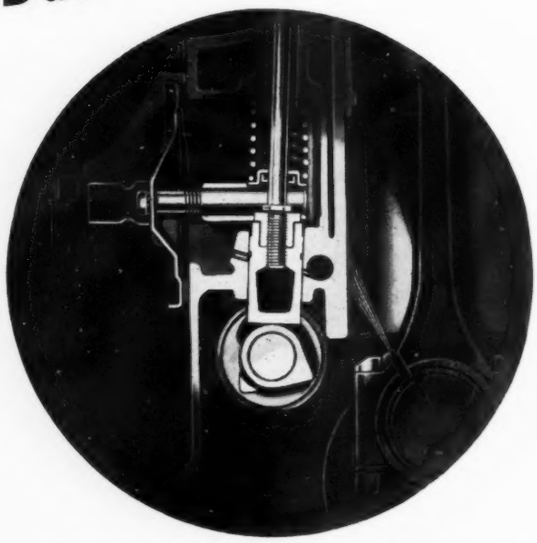
A war production conference on cleaning and related manufacturing operations recently was held concurrently by the entire field, mechanical engineering, chemical research, and general headquarters staffs of Oakite Products, Inc., in New York, Chicago, and Los Angeles. Sessions of the three-day program of each division conference were devoted to the discussion of improved ways to speed-up output in connection with the production of airplanes and motors, shells, cartridge cases, guns, tanks, bombs, fire-control instruments, communication equipment, helmets and a wide range of ordnance matériel and war supplies. In this connection, particular emphasis was placed on the production cleaning of iron, steel, brass, bronze, zinc, aluminum, magnesium, and other metals and alloys by tank and automatic washing machine methods before inspection, assembly, and finishing operations.

In addition to these and related production operations, each conference reviewed specialized methods and procedures for effectively handling some of the principal new cleaning problems regarding equipment maintenance and plant safety that war conditions are bringing to petroleum producers, oil refineries, natural gasoline plants, and pumping stations.

Topics discussed from these standpoints include shortening down-time for required maintenance on heat exchange equipment such as oil coolers, preheaters, steam generators, and dephlegmators by efficient cleaning practices; safely descaling water jackets and cooling systems of engines, compressors and condensers; reconditioning oil drums; steam cleaning heavy equipment to facilitate inspection and overhaul; and improved salvage cleaning methods for reclaiming valves, fittings, pumps, gears, and various other machinery and non-machinery items.

According to J. A. Carter, assistant to the president, this Oakite conference provided a means of quickly exchanging information on all phases of industrial cleaning that is made readily available through the medium of the company's nation-wide field service staff to executives responsible for producing and refining equipment maintenance.

Pressure Lubricated Barrel-Type Tappets!



These Red Seal Continental heavy duty barrel-type tappets have larger bearing area. Adjustment is simple and the lock effective.

Other important features in Red Seal Continental Engines for oil field service are—directional cooling—full length water jacket—interchangeable bearings — counter-weighted crankshaft with precise balancing — internally sealed water pump — and individual porting for quick starting, maximum power, economy, and flexibility.

CHARLES W. CARTER COMPANY

Distributors in

SAN FRANCISCO • LOS ANGELES • SACRAMENTO • OAKLAND • FRESNO

Continental Motors Corporation
MUSKEGON, MICHIGAN

Oil Center Tool Elects Officers

A. J. PENICK

The board of directors of Oil Center Tool Company, Houston, Texas, has announced the re-election of A. J. Penick, president, and H. D. Start, vice-president and plant manager. B. V. Fisher, formerly vice-president and sales manager, has been elected secretary-treasurer. Fisher will continue to supervise the sales of the company.

H. D. START

B. V. FISHER

Dave Harris Promoted

D. R. (DAVE) HARRIS

D. R. (DAVE) HARRIS has been appointed Mid-Continent general salesman of the Reed Roller Bit Company, with headquarters in Tulsa, Oklahoma. He was formerly stationed at the company's plant in Oklahoma City.

Harris replaces Fred L. Tyler who has been transferred to the Los Angeles branch as division manager.

Prosser New Mid-Continent Sales Manager for D+B

Emsco Derrick and Equipment Company announces the appointment of Frank L. Prosser as sales manager for its D + B Division in the Mid-Continent area with headquarters in Dallas, Texas.

FRANK L. PROSSER

Prosser is a native of Oklahoma, having received his high school and college education in Guthrie. He spent six years with the Santa Fe Railroad before going with the Shell Oil Company in 1923. He gained a wide experience in the production and material departments of Shell until 1936 when he became associated with Emsco.

Prosser is well acquainted in the oil industry, having worked in Kansas, Oklahoma, and Texas. He goes to his new duties from San Antonio where he has been covering South and West Texas for D + B since 1936.

D + B pumps and sucker rods are distributed in the Mid-Continent area through the Continental Supply Company, Dallas.

R. F. Vogt, Allis-Chalmers Chief Consulting Engineer, Dies

Robert F. Vogt, chief consulting engineer of the Allis-Chalmers Manufacturing Company since 1937 and an employee of the company for 36 years, died recently after a week's illness.

Vogt's professional career began in the United States about 40 years ago, when he came here from Switzerland, where he was born. He was a graduate of the Swiss Polytechnicum at Zurich. He joined the Allis-Chalmers organization in 1907 as a mechanical engineer.

After years of experience in design and development work in various departments, Vogt was appointed assistant chief consulting engineer in 1921. In 1937 he succeeded J. F. Max Patitz as the company's chief consulting engineer.

Vogt, 62, is survived by his widow, Flora, and a son, Paul Richard, Detroit. He was a member of the American Society of Mechanical Engineers, the Society of Automotive Engineers, and Kenwood lodge, No. 303, F. and A. M.

Save Up To 80% On Vital Materials with MARTIN PLUNGERS

HOW?

1. Martin Plunger Bodies require less steel and last longer.
2. Martin Rubber and Fabric Rings last longer.
3. Your pump tubes last longer.

Here's what one of several hundred operators says about his Martin Plungers:

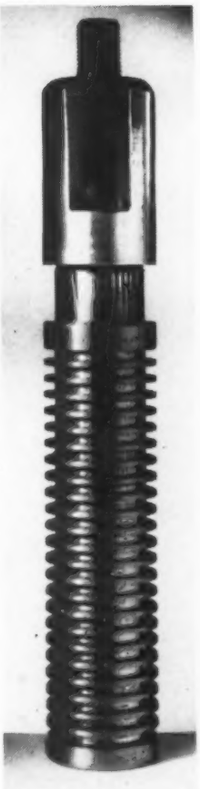
"This Martin Plunger Body (see cut at right) and two smaller ones saved us over 150 pulling jobs on our J. T. Wilson Lease near Bristow, Oklahoma, in four years of service, and prolonged the life of the lease at least three years."

(Signed) D. B. MASON
Independent Producer
Tulsa, Oklahoma

Only Martin Plungers have the one-piece "fluid-proof" bodies and "compensated" precision packing rings.

Sold Only Through Supply Stores
See Page 1551, Composite Catalog

Field Representatives:
TOM HULETT, El Dorado, Ark.
C. J. BAETEN, Wichita, Kans.
LYNN C. HOLLOWAY, Houston, Texas
J. WALTER WADE, Olney, Ill.
HUGH ROBINSON, Blackwell, Ok.
E. M. SCAGGS, Longview, Texas
F. M. WILSON, Wichita Falls, Texas
J. B. ALEXANDER, Odessa, Texas



Martin Plunger Body after four years use.

JOHN N. MARTIN
Manufacturer
11 W. Brady St. Tulsa, Okla.

Robert Grant Made Vice-President Young Radiator

Appointment of Robert Grant as vice-president in charge of manufacturing of the Young Radiator Company, Racine, Wisconsin, has been made by Fred M. Young, president. He has been associated with the Young organization for the last year as executive in manufacturing.

Grant's new responsibility is the result of further expansion in the war production field by the Young Radiator Company. He was educated at Cornell University and is a member of the Society of Automotive Engineers. He received his early production training as a line superintendent with the Nash Motors Division of the Nash-Kelvinator Corporation. He later filled other important assignments in the production and management field before becoming associated with the Young Radiator Company.

Rose General Manager Jas. P. Marsh Corporation

A new post has been created in Jas. P. Marsh Corporation, Chicago, Illinois, to take care of enlarged activities.

A. D. Rose, for many years sales manager, has become assistant general manager, and the position he has vacated will be filled by James Emmett, Jr., formerly assistant sales manager. "Al" Rose and "Jim" Emmett are well known in the oil industry.

Schwanhausser Elected Worthington Director

Edwin J. Schwanhausser, Buffalo, New York, vice-president, Worthington Pump and Machinery Corporation, has been elected to the corporation's board of directors, filling a vacancy created by the death of Edward T. Fishwick.

Schwanhausser has been a vice-president of the company since 1939, and a member of the Worthington organization since his graduation from Stevens Institute of Technology in 1915. For 14 years he was connected with the Harrison, New Jersey, Works, being appointed assistant manager in 1927. In 1929 he was appointed manager of the Buffalo Works, and was advanced to the position of vice-president in 1939, assuming in addition to general administrative duties, responsibility for directing the company's sales of Diesel and gas engines. Prominently identified for many years with civic activities, Schwanhausser served in 1937 and 1938 as president of the Buffalo Chamber of Commerce. He is a trustee of the Buffalo Savings Bank, and a director of Electro-Refractories and Alloys Corporation of Buffalo.

In addition to Schwanhausser, all retiring directors were reëlected at the annual meeting of stockholders held in Wilmington.

OPA Establishes Petroleum Section at Dallas

The Office of Price Administration has established a Petroleum Section in the Price Division of the Dallas Regional Office, and has appointed Osher Goldsmith, a consulting petroleum engineer of Tyler, Texas, as senior business specialist in this section. The territory of the Dallas Regional Office covers the states of Texas, Louisiana, Arkansas, Oklahoma, Missouri, and Kansas.

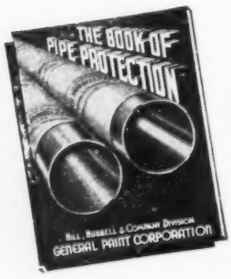
Inquiries of the petroleum industry pertaining to petroleum and its products under the Price Control Act in the above territory should be directed to the Dallas Regional Office in the Tower Petroleum Building.

Goldsmith is a registered professional engineer, and a graduate of the Missouri School of Mines, Class of 1920. He has been associated with both independent and major companies, as well as having been an independent producer himself.

The Life of Unprotected Pipe, too, is Limited

HILL-HUBBELL
***STEEL PIPE* PROTECTION**
profitably prolongs pipe life

The Book of PIPE PROTECTION which describes our process in detail will be mailed to you on your request.



Your underground Steel Pipe will have long, economical life if proper protection is provided when it is installed.

Mechanically Coated-and-Wrapped STEEL PIPE protection is modern, effectively practical, economical.

When you use the HILL-HUBBELL Factory Process job, you get COMPLETE pipe protection.

Hill-Hubbell Coated-and-Wrapped pipe is produced at these leading mills:

- Jones and Laughlin Steel Corp.
- National Tube Company
- Republic Steel Corporation
- Spang Chalfant, Inc.
- The Youngstown Sheet and Tube Company

GENERAL PAINT CORPORATION
HILL, HUBBELL & CO. • Division • Cleveland, Ohio
• EXPORT OFFICE: SAN FRANCISCO, CALIFORNIA, U. S. A. •

Walter Geist New President Allis-Chalmers

Max W. Babb, board chairman of the Allis-Chalmers Manufacturing Company, Milwaukee, Wisconsin, has announced the election of Walter Geist as president of the company to succeed W. C. Buchanan, whose resignation a few weeks ago was caused by ill health. Thus, a man who entered the company's employ as an errand boy in 1909, now at the age of 48 years assumes control.

One of Geist's outstanding achievements was the development of the multiple V-belt drive known as the Texrope V-belt drive. The importance of the Texrope Drive to American industry was recognized in 1940 when a committee of distinguished scientists, headed by Dr. Karl T. Compton, president of the Massachusetts Institute of Technology, awarded Geist the coveted honor of the "Plaque of a Modern Pioneer" for his research and original work in the power transmission field.

In April of this year, upon resignation of Buchanan, he was made executive vice-president by the board of directors, and a month later was elected president of the company.

Buchanan retains his membership on the board of directors and executive committee of Allis-Chalmers Manufacturing Company, which positions he has held for several years.

Iverson Tool Appointed Bucyrus-Erie Distributor

Iverson Tool Company, Tulsa, Oklahoma, has been appointed distributor for Bucyrus-Erie Spudders in the state of Oklahoma, according to a recent announcement from Bucyrus-Erie Company. The new Iverson territory includes all of Oklahoma except the three panhandle counties, which will continue to be served by Murray Tool and Supply Company, Pampa, Texas.

Iverson headquarters are at 215 West Second Street, Tulsa. There is also an Iverson store in Oklahoma City and a store and shop in Okmulgee.

In addition to the Oklahoma territory, Iverson is also distributor for Bucyrus-Erie Spudders in Chaves, Eddy, Roosevelt, and Lea counties, New Mexico, and part of western Texas. These territories are served by Iverson offices in Artesia and Fort Worth. As heretofore, Bucyrus-Erie Spudder distributors in the Southwest will work in coöperation with the Bucyrus-Erie branch office, 1806 Tower Petroleum Building, Dallas, Texas.

Pacific Pump Works Enlarging Facilities

Quadrupling of all present plant facilities, for the manufacture of aircraft hydraulic actuating assemblies and accessories, is under way at Pacific Pump Works, Huntington Park, California. The new buildings being erected in this expansion program are of steel, fire-proof construction. Additional employees are being trained to meet the increased production demands.

Pacific Pump has had long experience in the manufacture of precision parts of the same kind that are used in making hydraulic actuating assemblies. The component parts of these units are similar to those used in reciprocating oil-well plunger pumps, which constitute a large portion of Pacific Pump Works' normal production, and require the same high precision of design and manufacture.

Actuating assemblies of many types, including wing-flap, nose-wheel, landing gear, bomb door, etc., are being manufactured by Pacific Pump Works on a production basis.

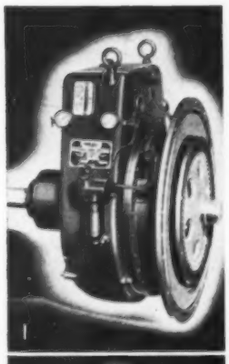
Douglas, Boeing, Lockheed, North American, and other leading aircraft companies are listed among Pacific Pump Works' customers.

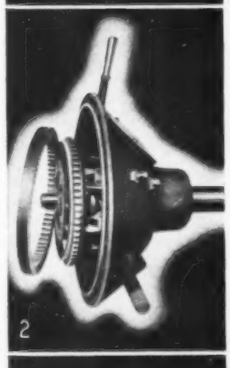
No time to lose!

America at war cannot afford a single minute of lost production due to breakdown . . . to time out for repairs. Every minute saved brings us closer to our goal: Winning the War!

In all types of rigs and pumping units, Twin Disc Clutches and Hydraulic Drives are giving the dependable service that only years of research and specialization can assure.

No matter where your rig may be located, you can be sure of competent service or parts for your Twin Disc Clutches, Power Take-offs or Hydraulic Drives. At Dallas, Tulsa, and St. Louis, within easy reach of the three major oil producing regions, are three of Twin Disc's seven factory branches. In every active field, you'll find one of the 30 parts stations, all prepared to meet your service and parts need at any hour of the day or night. The Twin Disc factory's complete stock of parts assures prompt shipment, even for exceptional or unusual demands. This complete service organization protects you against interrupted operations, helps you to maintain emergency schedules. TWIN DISC CLUTCH CO., 1329 Racine Street, Racine, Wisconsin.





1. Twin Disc Hydraulic Torque Converter. In considering installation, ask for complete data and specific recommendations. 2. Twin Disc Model E Clutches, heavy-duty, enclosed type. Sizes: 14" to 42" in single or two-plate assemblies. 3. Twin Disc Power Take-off for engines having up to 285 hp. output. Sizes: with single plate clutches, 6½" to 24"; double plate, 11½" to 18". Housing sizes: No. 6 S.A.E. to No. 00 S.A.E.

Alabama: Montgomery, Parts Service Corp. **California:** Los Angeles, Charles W. Carter Co.; San Francisco, Charles W. Carter Co. **Colorado:** Denver, Liberty Trucks & Parts Co. **Florida:** Jacksonville, Motor Parts & Supply Co. **Illinois:** Chicago, Wisconsin Industrial Parts. **Kansas:** Great Bend, Scheufler Supply Co. **Kentucky:** Lexington, Wombwell Auto Parts Co. **Louisiana:** New Orleans, Mechanical Equip. Co. **Maine:** Portland, Southworth Machine Co. **Massachusetts:** Boston, Rapp Huckins Co., Inc. **Michigan:** Detroit, W. C. Ducomb Co., Inc. **Minnesota:** St. Paul, Truck Parts, Inc. **Missouri:** St. Louis, Twin Disc Clutch Co. **New York:** Buffalo, Edward W. Rode, New York, Twin Disc Clutch Parts & Service of New York, Inc. **Ohio:** Cincinnati, C. McCash, Cleveland, Twin Disc Clutch Co.; Cleveland, Industrial Engine Parts. **Oklahoma:** Tulsa, Twin Disc Clutch Co. **Pennsylvania:** Philadelphia, Twin Disc Clutch Parts & Service of Philadelphia; Pittsburgh, Contractors Equip. Ser. Co. **Tennessee:** Knoxville, Automotive Equip. & Supply Co.; Memphis, Choctaw Culvert & Machinery Co. **Texas:** Dallas, Twin Disc Clutch Company; Fort Worth, John Muller Co.; Houston, Portable Rig Co., Inc.; John Muller Co. **Utah:** Salt Lake City, Lund Machinery Co. **Virginia:** Richmond, Standard Parts Corp. **Washington:** Seattle, Twin Disc Clutch Co.

TWIN DISC
CLUTCHES AND HYDRAULIC DRIVES
REG. U.S. PAT. OFF.

Chemical Exposition To Be Held in November

Leading chemical companies of America are to be represented with exhibits at the National Chemical Exposition, which will be held November 17, 18, 19, 20, 21, and 22 at the Stevens Hotel in Chicago, Illinois. This became apparent when the show committee of the Chicago Section of the American Chemical Society, sponsor of the exposition, announced that the list of exhibitors already under contract and many who have made space reservations include the names of some of the country's most outstanding firms in the chemical industry.

The importance of the exposition will be enhanced by the National Industrial Chemical Conference to be held in conjunction, with noted industrial chemists, educators, and manufacturers to be invited to make addresses and lead the discussions. Those who attend the show and conference may participate in this open forum.

"The show and conference will be an essential part of the industry's war effort," said Victor Conquest, chairman of the show committee. "It has been said that 'battles in 1943 and 1944 will not be won with equipment modern in 1942.' Scientific research and engineering cannot sit idly by during this war emergency. It is within the bounds of reason that the research laboratory and engineering table may win the war for us or our enemies.

"The 1942 National Chemical Exposition is a coöperative effort to organize the full force of science as it is concerned with chemistry into the colossal task of keeping our war machine out in front with the most highly developed scientific advancements that our country can produce.

"This applies to essential civilian needs as well as war production. Some of our more perplexing problems demand the personal contact that is provided by no other means than the National Chemical Exposition and conference for obtaining the quick solution that is so urgently needed."

It is announced that the show this year will be twice as large in floor area as the first exposition. More than 40,000 sq. ft. have been made available in the exposition hall and adjoining ball rooms at the Stevens Hotel for the coming exhibition. The Grand Ball Room, with adequate seating capacity, has been reserved for the conference programs.

Serving on the show committee with Conquest, who is Director of Research for Armour and Company, are: A. Guillaudeu of Swift and Company; W. M. Hinman of the Frederick Post Company; W. C. Johnson of the University of Chicago; L. E. May of the Sherwin-Williams Company; R. C. Newton of Swift and Company, and H. E. Robinson of Swift and Company.

The Advisory Committee, working closely with the sponsors, is composed of: Bruce K. Brown, manager of research and development, Standard Oil Company (Indiana), Chicago; J. V. N. Dorr, president, The Dorr Company, Inc., New York, New York; Willard H. Dow, president, Dow Chemical Company, Midland, Michigan; Gustav Egloff, director of research, Universal Oil Products Company, Chicago; Otto Eisenschiml, president, Scientific Oil Compounding Company, Chicago; Harry N. Holmes, head of the Department of Chemistry, Oberlin College, Oberlin, Ohio; Harrison E. Howe, editor, *Industrial and Engineering Chemistry*, Washington, D. C.; Ward V. Evans, professor of chemistry, Northwestern University, Evanston, Illinois; William Lloyd Evans, chairman of the Department of Chemistry, Ohio State University, Columbus, Ohio; S. D. Kirkpatrick, editor, *Chemical and Metallurgical Engineering*, New York, New York; H. R. Kraybill, director, Department of Scientific Research, American Meat Institute, Chicago; A.

Dependable Protection

Assured with REILLY Pipe Coatings

● The protection to water, gas and oil pipe lines provided by REILLY PRIMER AND PIPE ENAMEL has been proved in thousands of miles of installations, many of which have been in service over extended periods of years. These coatings, applied inside and outside of large mains and conduits, effectually prevent tuberculation, rust and corrosion. They are easily applied and safely withstand temperature changes. Smaller pipes when placed underground, or when exposed to moisture and destructive gases need these coatings also. Write for literature.

Reilly COAL TAR PRODUCTS

REILLY TAR & CHEMICAL CORPORATION

Executive Offices: Merchants Bank Building, Indianapolis, Indiana

2513 S. DAMEN AVENUE, CHICAGO, ILLINOIS 500 FIFTH AVENUE, NEW YORK, N. Y. ST. LOUIS PARK, MINNEAPOLIS, MINN.

FIFTEEN · PLANTS · TO · SERVE · YOU

H. Mellinger, president, Chicago Association of Commerce, Chicago; George W. Merck, president, Merck and Company, Rahway, New Jersey; Thomas Midgley, Jr., vice-president, Ethyl Gasoline Corporation, New York, New York; Carl S. Miner, director, Miner Laboratories, Chicago; Walter J. Murphy, editor, *Chemical Industries*, New York, New York; Harry McCormack, professor of chemical engineering, Illinois Institute of Technology, Chicago; Charles L. Parsons, secretary, American Chemical Society, Washington, D. C.; H. I. Schlesinger, professor of chemistry, University of Chicago, Chicago, Illinois; N. A. Shepard, chemical director, American Cyanamide Company, New York, New York; C. R. Wagner, chief chemist, Pure Oil Company, Chicago, Illinois; E. R. Weidlein, director, Mellon Institute, Pittsburgh, Pennsylvania; Frank C. Whitmore, dean of the School of Chemistry and Physics, Pennsylvania State College, State College, Pennsylvania, and E. C. Williams, vice-president and director of research, General Mills, Inc., Minneapolis, Minnesota.

Marcus W. Hinson is show manager, with headquarters at 110 North Franklin Street, Chicago.

Annual Summer Meeting S.A.E. Will Not Be Held

This year's Annual Summer Meeting of the Society of Automotive Engineers will be taken to the Society's membership by special local meetings and a special "Summer Meeting Issue" of the *S.A.E. Journal*, John A. C. Warner, secretary and general manager of the Society, has announced.

Continued presence of diplomats of enemy countries at White Sulphur Springs, and the inability of railroads to guarantee sufficient Pullman accommodations for the members to meet at any other suitable place, have ruled out holding the geared-to-war meeting as planned. The papers that were to have been presented, however, will be given at a number of local meetings sponsored by the Society's National Activity Committees, and many will also be published in the July issue of the *Journal*, he said.

A vast amount of technical information has already been accumulated by engineers of the automotive industry in the conversion of its peacetime facilities to a huge, widespread arsenal. The "mountain" of technical fare will thus be brought to the engineering "mohammeds" of the industry, the men responsible for engineering the huge production task ahead—a war-dictated reversal of the ancient proverb.

Lincoln Detroit District Manager Called to Service

A. F. Boucher, district manager of the Detroit office of The Lincoln Electric Company, Cleveland, Ohio, has been called to active duty in his capacity as a reserve officer. He will be attached with the Ordnance Department, and for the time being will be stationed with the Detroit Ordnance District.

Boucher's duties as district manager of the Detroit office will be assumed by C. H. Buckmaster of the company's Pittsburgh office, and J. H. Cunningham of the Detroit office will take over Buckmaster's duties at the Pittsburgh office.

The company simultaneously announces that George Bain is being transferred from the Detroit area to the Saginaw area.

National Petroleum Ass'n To Meet Sept. 16-18

The Annual Meeting of the National Petroleum Association will be held at the Hotel Traymore, Atlantic City, New Jersey, September 16, 17, and 18, it has been announced.

Save Time by Using COLMONOY Hard Surfacing Alloys

The head of a welding company recently wrote our engineering department. He had never used COLMONOY—and wanted full information as to the proper grades to use, prices and methods of application.

Part of his letter read as follows:

We have a particular problem presented by the packing sleeve of a hot oil pump in a nearby refinery. The last sleeve was faced with COLMONOY *and lasted three to four times as long as the original faced sleeve. We have been asked to bid on a set of sleeves faced with* COLMONOY *No. 6.*

One large oil company ran comparative tests, pumping hot oil at 900° and pump running at 3600 R.P.M. The COLMONOY coated pump sleeves ran for 2400 hours, against 360 hours for other sleeves.

You can save time, increase production and cut costs by coating all parts subject to excessive corrosion and abrasion with COLMONOY—pump sleeves, wash pipes, plungers, rings and many other parts of oil producing equipment.

COLMONOY will keep new parts on the job longer—and many worn out, discarded parts, when COLMONOY coated, will outwear and outperform new, uncoated parts many times over.

Write Today for Full Information

WALL-COLMONOY CORP.

Buhl Building, Detroit, Michigan

Branch Offices

NEW YORK CITY, BLASDELL, N. Y.; CHICAGO; TULSA; WHITTIER, CALIF.

Other branches in Canada

COLMONOY

Hard Surfacing Alloys and Overlay Metals

California Group Elects Officers

Lawrence Vander Leck, president of Oil Producers Agency of California during the Agency fiscal year 1941-1942, was elected to a second term, ending in April, 1943, by the Agency Board of Directors in their annual meeting.

The board also re-elected Rush M. Blodget executive vice-president, a position he has held since the Agency was organized in 1930.

Vander Leck, vice-president of Fullerton Oil Company, is a member of the Production Committee for District No. 5 of the Petroleum Industry War Council, is a member of the Conservation Committee of California Oil Producers, and a director of the California Oil and Gas Association.

The Agency board also elected two new vice-presidents, W. C. Whaley of the Barnsdall Oil Company, and H. E. Woodworth of the Safe Oil Company. L. A. Cranson of the Honolulu Oil Corporation, and C. P. Watson of the Seaboard Oil Company, were re-elected vice-presidents. W. A. Russell, Seaboard Oil Company, was re-elected secretary-treasurer, and H. S. Briscoe, Franco-Western Oil Company, was elected assistant secretary-treasurer.

The following directors also were elected to fill vacancies caused by expiration of three-year terms: Angus J. Crites, Jack Feldman, Robert H. Garrison, James H. Lewis, Ralph B. Lloyd, Roy W. Young, Maurice A. Machris, John B. Sutherland, C. P. Watson, Chas. G. Wilson, and H. E. Woodworth. In addition to the newly-elected directors and officers, the complete Agency board includes: W. L. Adkisson, L. L. Aubert, H. A. Bardeen, Alphonzo E. Bell, J. J. Doyle, W. S. Fisher, Earl Fleisher, Wm. H. Geis, R. E. Havenstrite, Dana Hogan, C. A. Johnson, DeWitt Knox, Robt. S. Lytle, Cecil M. Rood, C. C. Spicer, Dwight G. Vedder, W. D. Waltman, Laurence I. Weill, and Lloyd Williamson.

HALT! DON'T WALK ON THOSE RODS . . .

Serve America by saving what you have! Walking on rods that have been laid down may seem harmless enough. Yet, one rod may be bent, followed by premature fatigue and failure and damage to the whole string. Be sure to use at least four evenly spaced supports under rods that are laid down. Make sure that bell nipples and elevators are in good condition, and seat evenly. This helps prevent kinking just below the upset.

The S. M. Jones Company is glad to offer suggestions on how to get better service and longer life from sucker rods now in use. However, this is only one example of the responsibility we have always felt toward the industry we have served exclusively for 51 years. Our duty, in wartime, is plain. This knowledge comes from the experience of serving the oil industry through two other wars.

The S. M. JONES Co.
JoneSuckeRods
General Office and Factory, Toledo, Ohio Sales Office, McBirney Bldg., Tulsa, Okla.

OPC Designation Changed

Petroleum Coördinator Harold L. Ickes has announced that the President has authorized changing the designation of the "Office of Petroleum Coordinator for National Defense" to the "Office of Petroleum Coördinator for War."

The change, Coördinator Ickes stated, was approved by the President as being "more appropriate to the situation existing today."

The Office of Petroleum Coördinator was established by the President last May 28, in order to assure "the development and utilization with maximum efficiency of our petroleum resources and our facilities, present and future, for making petroleum and petroleum products available, adequately and continuously, in the proper forms, at the proper places and at reasonable prices to meet military and civilian needs."

Safe Practices for Cleaning Tanks Described In A.P.I. Manuals

Recommended safe practices for cleaning crude petroleum and gasoline storage tanks are described and illustrated in two manuals published by the American Petroleum Institute's Department of Accident Prevention.

The manuals, which are a revision of the single manual previously issued, give in detail the procedure recommended for cleaning tanks, the dangers involved, and the protective equipment that should be used.

Section A, "Crude-Oil and Unfinished-Products Tanks," covers petroleum-vapor fires and explosions; sources of combustible vapor mixtures; sources of vapor ignition; toxic gases and vapors; oxygen deficiency; use of tools, planning and inspection; draining and

isolating tank; removal of gases and vapors; opening tank; iron-sulphide deposits; removal of sediment; testing for vapor or gas, and how tests are made. Protective equipment is described, and recommended safe practices and precautionary measures are listed.

Section B, "Gasoline Tanks," covers in general the same subjects, but with special emphasis on the different hazards, the smaller tanks often involved, and the extra precautions necessary with leaded gasolines.

Copies of the two manuals may be obtained from the Institute, 50 West 50th Street, New York. Price is 25 cents each.

C. N. Barney Elected Worthington Vice-Pres.

The board of directors of Worthington Pump and Machinery Corporation has elected Charles Neal Barney of Scarsdale, New York, a vice-president of the corporation. A member of the Worthington organization since 1918, he has been treasurer since 1931, as well as the head of the corporation's legal department.

Barney formerly practiced law in Massachusetts and was a lecturer at Northeastern Law School and Boston University Law School. He is a member of the American, Massachusetts, and New York Bar Associations, author of the law text, "Equity and Its Remedies," and was, early in his career, Mayor of Lynn, Massachusetts.

Ordnance Office Honors Lincoln Electric

Captain H. M. Reid of the Cleveland Ordnance District recently presented to J. F. Lincoln, president of The Lincoln Electric Company, a letter of appreciation from the Office of the Chief of Ordnance, Washington, D. C., for the coöperation of the Lincoln School of Arc-Welding in providing welding instruction for ordnance inspectors.

The presentation was made in Lincoln's office in the presence of H. P. Morley and W. J. Haring, civilian assistants in Captain Reid's personnel and training division. Also present were A. F. Davis, Lincoln vice-president, and J. R. Morrill, assistant to the vice-president and in charge of the Lincoln School.

The letter presented to Lincoln was signed by C. T. Harris, Jr., major general, assistant to the chief of ordnance, chief of industrial service, War Department. It read as follows:

"The Ordnance Department wishes to acknowledge its appreciation for the manner in which your company has cooperated with the Cleveland Ordnance District in the establishment of a training course for welding inspectors at your plant.

"The excellent quality of instruction, together with the suggestions and courtesies extended to representatives of the Ordnance Department, have been very helpful in the present emergency."

In his acceptance, Lincoln said, "We are very grateful for this recognition and we are certainly glad that we can be of service in this important work."

The course of training at the Lincoln Welding School for Ordnance inspectors was arranged at the request of the Washington office of the Ordnance Department. Its primary purpose is to provide instruction for men who will inspect welding on tanks. The Lincoln company has collaborated extensively with government technicians in adapting welded construction in tank production and has developed special electrodes for welding armor plate.

"CLEVELANDS"

Will Cut Hours Off Your Pipe Line Construction Schedules

HERE'S a machine that will save you money from the word "go"—and be just as ready to go on the second hundred miles as the day you bought it. Under every conceivable condition, whether it's tropical swamps, rocky ground, mountainous territory, abrasive sand, sticky mud, or just plain ordinary dirt, the "CLEVELAND 140" leaves nothing to be desired in the way of performance.

The "140" is a balanced combination of all the features which have been found most desirable for pipeline ditching, such as: ample power for the toughest tasks—speed and fast maneuverability—dependable, tested, full-crawler traction—wide tread and low ground pressure—multi-speed transmission—enclosed gears—double strength steel in frame, boom and ditcher-buckets—quick accessible unit type construction—box-type ditcher boom—and super quality materials throughout. You just can't miss when you pick "CLEVELANDS" for your ditching jobs, for they're built to produce and endure.

THE CLEVELAND TRENCHER COMPANY

20100 ST. CLAIR AVE. "Pioneer of the Small Trenches" CLEVELAND, OHIO

"CLEVELANDS" Save More . . . Because they Do More

Book Reviews

Progress Report of Special Study Committee on Standards of Allocation of Oil Production Within Pools and Among Pools, published by The American Petroleum Institute, 50 West 50th Street, New York, New York. Price $1.50.

This book is a progress report of the A.P.I.'s special study committee on well spacing and allocation of production and its legal advisory committee and contains fundamental principles of oil production and recommended factors in the application of those principles to sound proration practices.

The committee reached nine conclusions from its studies, and these are summarized at the beginning of the report. They cover the necessity for conservation, the causes of waste, and the principles of regulation and allocation that should be adopted to prevent waste.

Divided into eight sections, the report contains the introduction, conclusions, recommendations, principles of conservation, technology of petroleum production, applicable legal principles, allocation within pools, and allocation among pools. Four appendices give the report of the legal advisory committee, a bibliography of legal phases of allocation of production, a bibliography of engineering phases of production, and a report of the engineering committee of the Interstate Oil Compact Commission.

"Conservation requires restrictions of production," the report points out, and "restriction of production creates the problem of allocating the allowables" among pools, and among the separate owners of properties in each pool. "The technical, legal, and economic components of the whole problem are so closely intertwined that it is impossible to isolate them for separate study. This report has endeavored to present these various aspects in their true dependent relationship."

●

Practical Arc Welding, by W. J. Chaffee, published by Hobart Trade School, Inc., Box EW 80, Troy, Ohio. Price $2.00. 516 pp.

This text was written by the author of "Arc Welding and How to Use It," for the purpose of replacing the latter. It is intended to assist in developing trained personnel for industry utilizing arc welding. Due to the sudden acceleration of industrial activity caused by the national war program arc-welding has been recognized as an effective answer to most problems involved in speeding up production in an economical way and has resulted in an unprecedented demand for trained welding personnel.

The writer has kept in mind the needs of private and public educational institutions, vocational training schools, government defense training activities, and particularly the interests of welding operators and their employers in various industries.

In the text only the carbon arc section and certain unchanging tabular data have been retained in original form, and they are reproduced from all new type and all new plates. Many new features have been introduced in the book increasing its size by more than 100 pages.

Complete revamping of the operator's training course has been accomplished to meet modern conditions. The text is designed to give students such a thorough grounding of fundamentals that they are qualified for a wide variety of arc-welding applications, and can quickly adapt themselves to specialized needs of the day.

Monster from Mars?

Monster from Mars? No. A gargantuan earth leveller for building and levelling airplane landing fields . . . Another product of American industry in the big parade to Victory. Like so many of the new and improved products of American inventive and industrial genius, this giant grader has American Blower Fluid Drive. The trend to Fluid Drive continues, too, in many such time-proved applications as Diesel motorships, pumps, fans, conveyors, excavators, trucks, oil drill rigs, etc. If you are looking to the future, plan to include American Blower Fluid Drive in your new or proposed products.

Fluid Drives *for Industrial, Marine and Automotive Use*

AMERICAN BLOWER
HYDRAULIC COUPLING DIVISION
DETROIT, MICHIGAN
Division of AMERICAN Radiator and "Standard" Sanitary Corporation

Review of Heaving Shale Problem in Gulf Coast Region

KNOWN methods of conquering "heaving shale," geological formations that for more than a quarter of a century have retarded deep petroleum drilling in some Gulf Coast areas and have forced the abandonment of many exploratory holes and wells, have been reviewed by Gustav Wade of the U. S. Bureau of Mines and presented in a report for the use of the oil industry and associated groups.

It is stated in the report that advances in equipment and technology during the last 25 years have made possible the successful drilling of wells in some areas in Louisiana and Texas where attempts formerly had been frustrated by heaving shale formations and eventually the problem may be solved completely. The urgent wartime need for adding to the Nation's petroleum reserves undoubtedly will justify greater expenditure for exploratory work and give impetus to the industry's efforts.

"Heaving shale" surrounding a borehole is likely to shift or move when disturbed by the drilling of an oil well, thus permitting large masses of disintegrated material to slough off and fall into the hole, according to Wade. Some shales contain materials that swell to several times normal size when water enters the borehole, others are hard and compact, and difficult to penetrate with a drill. The crux of the problem of drilling through heaving shale is, according to the report, "the difficulty of establishing and maintaining a thin, tenacious, and relatively impervious mud sheath on the surface of the shale exposed in the borehole."

Throughout the years this has been one of the major problems in the development of the Gulf Coast oil fields, and the methods that have been found to be effective in many, if not all, of the fields are described in the Bureau's report as "mechanical" and "chemical" methods.

Early efforts to penetrate shale were largely mechanical. Improvements in drilling machinery have been utilized as they became available, and drilling technique was adapted to overcome the difficulties as they arose. More efficient pumps, drilling tools, casings, and other special devices have all contributed to the advancement in the mechanical field, the report states.

As for the chemical methods, the treatment of water muds in the boreholes with chemical solutions in an attempt to reduce the disintegration of shale during drilling came into use in the Gulf Coast area in 1930, the report states. This treatment is based upon the theory that a highly colloidal drilling mud would coat and seal the shale exposed in the hole, and retard the infiltration of water. As a result, mixtures of solutions of sodium silicate, caustic soda, crude tannic acid, and many other chemicals have been employed to combat heaving shale.

Detailed descriptions of individual wells in the Gulf Coast, together with the methods used to overcome heaving shale difficulties, form the bulk of the report. An important part of the report is a map showing the name and location of reported occurrences of heaving shale in Texas and Louisiana. There is also a selected bibliography of published articles on the subject.

A copy of the report may be obtained by writing for Report of Investigations 3618, "Review of the Heaving Shale Problem in the Gulf Coast Region," by Gustav Wade, to the Bureau of Mines, Department of the Interior, Washington, D. C.

——— ☆☆☆ ———

JUST A GLANCE TELLS THE PRESSURE!

Drillers really like the billboard figures of the Abercrombie Pressure Gauge. These figures, on a clear, steady dial behind a colorless, unbreakable plexiglass face, tell the whole story at a glance of the pressure being recorded on this sure, accurate gauge. The gauge is not affected by external vibrations, and pump pulsations are dampened over the entire pressure range without adjustments.

ABERCROMBIE PUMP CO. » GULF BLDG. » HOUSTON, TEXAS

Let Acme's New MUD-COLLAR Help You Lick the Materials Shortage Problem!

ACME DRILLING & FISHING TOOLS

Also makers of the Famous "Drillmor" Line of Drilling and Fishing Tools for Cable Drillers—The World's Standard of Quality Since 1900

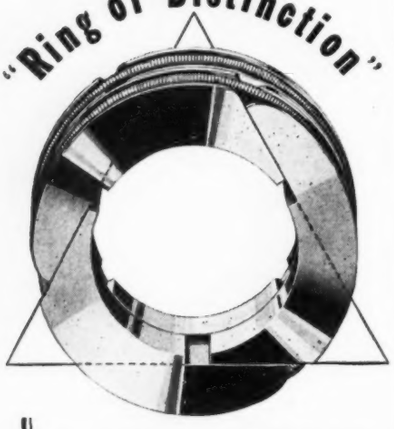
A product which will reduce wear and tear will not only soon pay for itself and protect profits but—*most important*—it will help relieve TODAY'S material shortage emergency. Acme's MUD COLLAR, the "modern-marvel" tool for rotary drilling, will do just THAT. And here are some definitely proven reasons why: *In any formation:* It lessens drill pipe torque; assures faster, easier cutting, longer runs, fewer "green bits" and makes better hole . . . Its 6 high-velocity fluid streams keep cutters clean, bit bearings "lubricated" and free of cuttings — while constantly flushing bottom . . . In sticky formations, it also prevents mud rings and "balled up" bits. Write NOW for full information about this "wonder tool"—that will help you decrease your material purchases by increasing the life of your bits and drill pipe.

Ask for Complete Catalog No. 12 — and Valuable Drillers' Manual.

Defense comes FIRST—with most of Acme's facilities now devoted to "essential production." But we'll serve YOU as best we can . . . and "friendly - like."

The Acme Fishing Tool Co.
PARKERSBURG, WEST VIRGINIA
Export Office: 19 Rector St., New York, N. Y.

"Ring of Distinction"



Install FRANCE Metal Packing for "'Round-the-Clock" PRODUCTION

The renewal of ordinary packing every few weeks or months increases horsepower and production costs.

Minimum friction is encountered with France Metal "Ring of Distinction" Packing. No undue force can be exerted on rods or stems by tightening the stuffing box stud nuts. The rings are free to float in the case that retains them and are held to the rod or stem with a garter spring having minimum tension.

The result is tight "full-floating," trouble-free performance *for years*. Prompt delivery assured.

FREE

44-page Catalog of useful and valuable information. Write for your free copy of Catalog M-3, with facts on

- **Packing Designs for Any Service**
- **Installation Procedure**
- **Methods of Lubrication**
- **Pressures and Temperatures**
- **Oil Return and Stripping Rings**
- **Handy Reference Tables**

Request France Engineers to analyze your packing requirements. There is a representative close at hand.

THE FRANCE PACKING COMPANY

Tacony Philadelphia Penna.

Mid-Continent Representative:

MR. J. M. FULLER, 2603 Azle Avenue
FORT WORTH, TEXAS

Original **FRANCE METAL PACKING**

Broderick and Bascom Awarded Navy "E"

Sixty-four years of continuous improvement in its manufacturing methods, coupled with a remarkable spirit of coöperation among its employees, won the Navy "E" for the Broderick and Bascom Rope Company, St. Louis, Missouri.

The two-pointed all-Navy burgee with a white "E" and anchor in the center—highest honor the United States Navy could give the company—was presented at fitting ceremonies held at the plant April 30.

Captain Edwin A. Wolleson, U.S.N. (retired), commanding officer, Navy Pier, Chicago, made the presentation. John K. Broderick, president of the rope company, accepted the burgee in behalf of the management, staff, and personnel.

In making the presentation, Captain Wolleson told the workers:

"You have contributed to a cause which we not only hold sacred—we, all of us—but the survival of which is, in sober truth, the answer for most of us between life and death. Make no mistake about that.

"This is not a sham, a paper war, fought on far distant shores. This is not a conflict which we can enjoy with a vicarious thrill, as did the crowds of the Coliseum at Rome, who watched gladiators locked in mortal combat but knew themselves to be safe.

"This is our war—yours and mine—and before it is over, unless I'm sadly mistaken, we shall all know the sound of gunfire, the smell of powder, the concussion of a bursting bomb.

"Our men are dying for the faith which they share with us. How great our responsibility to complete the magnificent work for which they are dying. That is your responsibility, your duty. And duty is not performed once, and looked back upon with smug satisfaction. Duty is performed every day—day in and day out. Do not think, then, because you have won honor you have reached your goal. That is only the beginning."

In accepting the award, J. K. Broderick emphasized that it had not been won by any concerted effort at a production record and that, in fact, none of the employees knew the company was being considered for the honor.

"The true significance of this award lies in the fact that it was won unknowingly and unsought in the regular day by day effort of the men and women of our organization in expressing their contribution toward the greater goal of victory.

"We have all clearly resolved without saying much to one another or to the world that when victory comes there will not be a reproachful thought to spoil our joy in our share of the great event. 'Well done' shall be said of us—and 'well done' we shall say to ourselves.

"The officials and staff of this com-

Climax of the Navy "E" Day celebration at the Broderick and Bascom Rope Company was the presentation and unfurling of the all-navy burgee, with its "E" and anchor. Above (left to right), Captain Edwin A. Wolleson, U.S.N. (Ret.), Commanding Officer, Navy Pier, Chicago, who made the presentation; Lloyd C. Stark, former governor of Missouri; William Dee Becker, mayor of St. Louis; Charles E. Bascom, secretary-treasurer, and John K. Broderick, president of the company, are shown displaying the emblem

pany are conscious of the responsibility and are deeply grateful and appreciative of this recognition of accomplishment. However, whatever of effort and planning on the part of the management, the achievement could not have been secured without the support and patriotic urge of our workers.

"They are duly proud of the privilege to wear the Navy "E" button which shall be cherished by them, and this emblem shall provide an incentive to further an ever-increasing effort."

Jack Schneider, 64, foreman of the stranding department, who started with the company as a boy, and Joe Saettele, foreman of the splicing department, accepted "E" buttons in the name of all company employees.

This is the second time Saettele has won such an award. The first time was in 1905 when he was a member of the gun crew aboard the U.S.S. Baltimore that broke the navy record for operating a 6-in. gun by scoring nine hits in one minute.

William Dee Becker, mayor of St. Louis and Lloyd C. Stark, former governor of Missouri, two of the many notables present, made brief addresses.

Westinghouse Honors Two Officials

A. W. Robertson, chairman of the Westinghouse Electric and Manufacturing Company, recently conferred the Westinghouse Order of Merit on G. Edward Pendray, assistant to the president in charge of publicity and advertising, and James Boyd, eastern district manager.

Each received a large bronze medal that bears on its face a silver "W" and his name, with the legend "Whom his fellow men delight to honor." The medal was designed by Rene Chambellan, the sculptor. Since its inception in 1935, the Order, highly prized by employees, has been awarded to 200 persons, for outstanding contributions to the electrical and mechanical arts and to company progress. With the medal a certificate with a citation is presented.

Pendray was cited "for his profound understanding of the mind of the public in its relation to a large industrial organization; for his sound and effective administration of publicity and advertising, and for his ability to combine individual initiative with coöperation within the company."

Boyd's citation was "for his clear-sighted, practical sales ability in serving a complicated metropolitan area; for his management of a sales organization under difficult conditions existing in that area; and for his personal salesmanship and courage in handling large and difficult negotiations."

CONSIDER THESE IRON BODY VALVES TO SAVE BRONZE

THE "KING-CLIP"—a husky iron body gate valve which employs bronze for the internal working parts only. For many services, the "King-clip" will serve equally as well as a bronze gate valve. Easily taken apart for cleaning. A valve that withstands hard and continuous usage.

THE "FERRENEWO"—an iron body globe valve that may be used instead of bronze valves for many services. All internal parts are made of non-corrodible alloys and are renewable. Seat and disc are regrindable. The "Ferrenewo" will give excellent service with negligible upkeep cost.

Investigate the adaptability of these iron body valves to your needs.

●

Since virtually all materials used in the manufacture of valves are on the list of critical materials, valve users are urged to furnish the highest possible preference ratings on their orders. This will be of mutual helpfulness.

Fig. 1640
"King-clip" Gate Valve
150 lb. S.P.

Fig. 1021
"Ferrenewo" Globe Valve
150 lb. S.P.

ESTABLISHED 1862
THE LUNKENHEIMER CO.
"QUALITY"
CINCINNATI, OHIO, U. S. A.
NEW YORK CHICAGO
BOSTON PHILADELPHIA
EXPORT DEPT. 318-322 HUDSON ST., NEW YORK

LUNKENHEIMER VALVES

Cathodic Section of P.I.E.A. Meets

The 1942 annual meeting of the Petroleum Industry Electrical Association held in Shreveport, Louisiana, April 21, 22, 23, 24, and 25, marked the second anniversary of the Cathodic Section as a part of the parent organization.

The Wednesday morning session, April 22, was devoted to reports of the various committees and election of officers for the coming year. The affairs of the Cathodic Section will be under the direction of H.C. Gear, chairman; F. J. McElhatton, vice-chairman; E. A. Koenig, secretary; aided by L. F. Scherer and G. R, Olson, counsels.

Wednesday afternoon the meeting was called to order by H. C. Gear, chairman, who introduced the first speaker, Wm. E. Huddleston, Cities Service Gas Company, whose paper "When and Where to Use Insulating Flanges" was presented.

"Maintenance Requirements for Adequate Operation of Cathodic Protection Equipment" was discussed by M. C. Miller, Ebasco Services, Inc.

R. A. Brannon, Humble Pipe Line Company, presented an analysis of current distribution and the effective results of reducing corrosion in his paper, "Cathodic Protection on Tank Farms."

Thursday morning the program of the general meeting was under the direction of the Cathodic Section. A brief explanation of the process was explained before presenting the first speaker, F. J. McElhatton, Panhandle Eastern Pipe Line Company, who presented a paper, "Economics of Cathodic Protection."

Ray M. Wainwright, Montana-Dakota Utilities Company, in his paper, "Cathodic Protection on Distribution Systems," pointed out the factors that determine whether it is economically feasible to apply cathodic protection, and called attention to the need for coöperative engineering in congested areas.

N. C. McGowen, president, United Gas Pipe Line Company, in his address, "Cathodic Protection and Corrosion from Management's Viewpoint," paid tribute to the pioneers in the cathodic protection field and the progress made in preserving and conserving materials.

Three papers were presented at the meeting Friday morning. Derk Holsteyn, Shell Refining Company, had as his subject "Current Density Determinations on Refinery Piping."

"Corrosion Problems on Refinery Equipment" was presented by V. L. Nealy, The Texas Company.

G. R. Olson, United Gas Pipe Line Company, has the distinction of designing a complete cathodic protection system for bare pipe lines, and in his paper "Recent Developments in Cathodic Protection of Bare Pipe Lines" he explained his design and pointed to the substantial saving in cost of protection equipment effected.

Friday afternoon Dr. K. H. Logan, U. S. Bureau of Standards, presented a progress report on the study of zinc-steel couplings.

A. B. MacTaggart, general manager of Rusta Restor Corporation, guest of the section, was invited to discuss the method of handling corrosion problems by his half wave rectifier and element anode circuit.

After the discussions the appointment of F. J. McElhatton as one of the directors of P.I.E.A. was announced and the following committees appointed:

Technological: R. A. Brannon, chairman; Wm. E. Huddleston, V. L. Nealy, O. C. Mudd, and W. F. Rogers.

Program: Wm. E. Huddleston, chairman; W. T. Pyott, Bruce Corey, and R. W. Sullivan.

Resolutions: W. T. Pyott, chairman; J. C. Stirling, and T. Williamon.

Inter-Company Proceedings: E. A. Koenig, chairman, O. C. Mudd, and G. M. Johnson.

POWER—where it's needed!

★ The amphibian tractor — a startling product of American industrial ingenuity — delivers *military power* where it will do the most good.

The electric network—another example of industrial resourcefulness — connects hundreds of operating electric companies and delivers *electric power* at points of need.

Built up by the business men who manage America's electric companies and produce ⅞ of America's power, this nation-wide web of electric lines has proved its vital value in the war emergency —by providing power for tank and plane plants, shipyards and arsenals, and for producing, pipelining and refining the fuel required to keep 'em rolling, flying and sailing.

DEPENDABLE GULF STATES UTILITIES CO PUBLIC SERVICE

GENERAL OFFICES—Beaumont, Texas, and Baton Rouge and Lake Charles, Louisiana

D. E. Morgenstern With International-Stacey

David E. Morgenstern, who has been affiliated with the Continental Oil Company's production engineering department in the Indiana and Illinois Basin, is now with the International-Stacey Corporation of Columbus, Ohio.

Morgenstern came to the United

D. E. MORGENSTERN

States from Poland in 1938, having studied mining engineering in that country and at L'Université De Liegé, Belgium. He graduated from Massachusetts Institute of Technology in 1939, then studied geology and engineering in the graduate school at Columbia University. In 1940 he accepted a position with the General Geophysical Company, Houston, Texas, and that same year joined the staff of the Continental Oil Company.

H. C. Price Company Enters General Pipe Line Contracting Field

H. C. Price Company, Bartlesville, Oklahoma, for many years engaged exclusively in electric welding pipe lines and oil-field casing, has announced that it is now prepared to contract the general construction of pipe lines throughout the United States.

As general pipe line contractors, H. C. Price Company offers complete personnel and equipment, available wherever pipe lines are to be constructed, it is announced. All types of pipe lines will be built by the enlarged organization.

Pioneers in the electric welding of pipe lines, H. C. Price Company has been a leader in that field for many years. This organization has electric welded more than 12,000 miles of oil and gas lines in both North and South America.

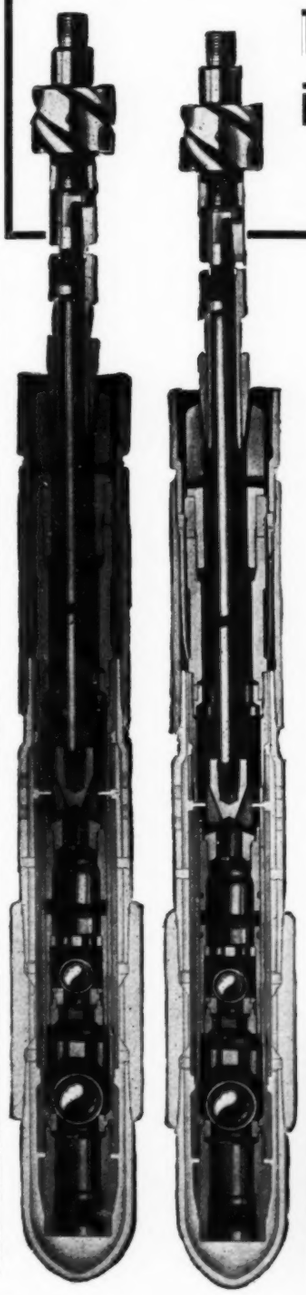
Exponents of thorough and extensive training in electric welding, the H. C. Price organization has been able to supply supervisors and welders to America's shipyards as an aid to the war effort.

The main offices of the company will continue to be at Bartlesville, Oklahoma, with branches at Effingham, Illinois, San Francisco, and Los Angeles.

D. L. Cobb of Lone Star Gas Passes Away

Delmore L. Cobb, 65, secretary-treasurer of Lone Star Gas Company and the last remaining executive who joined the company upon its founding in 1909, died May 9 at his home in Dallas, Texas.

Cobb was brought to Texas from Arkansas a year after his birth, his parents moving to Corsicana, the first Texas city to have natural gas service. He graduated from Southwestern University at Georgetown in 1898. His entry into the fuel industry was as secretary of the Navarro Oil and Refining Company where he remained 10 years. Joining Lone Star 33 years ago, he had a large part in shaping its policies and organizing its records and accounting procedure. At various times Cobb was active in numerous associations connected with the industry.



These AXELSON PUMPS insure economical pumping under tough conditions

Axelson R. S. L. rod type pumps are built to give economical satisfaction under tough conditions. By casting liners *in its own foundry*, Axelson is able to maintain rigid product control from laboratory through every manufacturing operation. You can be sure that "hard metal" liners and other parts in Axelson R. S. L. pumps are rigidly tested for uniformity and quality of all material.

Use of the double end Barnwell plunger, which incorporates an inwardly-beveled lip, prevents sand from getting between plunger and liner because it has a wiping action on both the down and up-stroke. This double action causes plunger to *drop quicker in heavier oil.*

The Perry valve on the plunger reduces gas lock to a minimum by allowing closer spacing of valves. It is also an excellent sand valve due to its streamline effect, thereby creating a greater velocity through plunger.

If you have a particular pumping job, it will pay you to call an Axelson representative now! They make a pump to fit every requirement!

AXELSON MANUFACTURING CO.
6160 Boyle Ave. (P. O. Box 98, Vernon Sta.)
Los Angeles, California
St. Louis New York Tulsa, Okla.

AXELSON 50th YEAR 1892 1942

AXELSON

SELLS AND SERVICES DEEP WELL PLUNGER PUMPS AND SUCKER RODS

A GOOD CEMENT JOB

Segregates
GAS, OIL & WATER

B and W, Inc.

WALL CLEANING GUIDES
Give you
A GOOD CEMENT JOB by

1 ELIMINATING MUD CAKE—Direct abrading action of multiple spring wires removes mud filter cake from wall of hole and affords good contact between cement and formation.

2 ELIMINATING "ZONE OF WEAKNESS" — Continuous centering of casing assures uniform thickness of cement. No "Zone of Weakness" where cement is dangerously thin.

3 ELIMINATING FLUID MIGRATION — A good cement job assured by B and W Guides means low gas/oil ratio and a satisfactory completion without the need for expensive re-cementing.

WRITE FOR BULLETIN 102

BRUCE BARKIS — B and W, Inc. — KENNETH WRIGHT
Well Completion Specialists
Makers of
B and W Wall Cleaning Guides
Gulf Coast & Foreign Distributors of
NELSON Pre-Packed Gravel LINERS
WILLIS ROTARY CHOKES
WEST COAST
3545 CEDAR AVENUE
LONG BEACH, CALIFORNIA
TELEPHONE: LONG BEACH 4-8366
GULF COAST
1105 COMMERCE BUILDING
HOUSTON, TEXAS
TELEPHONE: PRESTON 9783

Grove Regulator Honored With Navy "E"

Rear Admiral John W. Greenslade, Commandant of the Twelfth Naval District, making presentation of Navy "E" Award to Grove Regulator Company for excellence in the production of naval material

Grove Regulator Company, Oakland, California, is the first in that industrial city to receive the Navy "E" Award for excellence in the production of naval material.

Formal presentation of the coveted pennant to the company and Navy "E" pins to each of the workers was made by Rear Admiral John W. Greenslade, Commandant of the Twelfth Naval District.

In accepting the award on behalf of each man and woman engaged in his plant, Marvin H. Grove made a brief statement that should prove to be a real inspiration to other plants and workers similarly engaged in war production. Grove said: "Our production line is our battle line. Increased output is our objective. Armed with efficient batteries of machines and tools, we are pledged to maintain and even surpass our past record of productive achievement. Therefore, in accepting the responsibility which this recognition has placed upon us, we do not consider our work done, but only just begun."

Meeting Dates Changed

Dates for the Annual Meeting of the Independent Petroleum Association of America at Wichita, Kansas, have been changed to October 20, 21, and 22.

The Annual Meeting of the National Stripper Well Association, also to be held at Wichita, has been changed to October 19.

Westinghouse Elects Four New Vice-Presidents

Election of four Westinghouse executives to the rank of vice-president is announced by G. H. Bucher, president of the Westinghouse Electric and Manufacturing Company, following action by the board of directors.

They are Andrew H. Phelps of Pittsburgh, Pennsylvania, manager of purchases and traffic; L. E. Osborne of Philadelphia, Pennsylvania, manager of the steam division; Frank C. Reed of Jersey City, New Jersey, president of the Westinghouse Electric Elevator Company, a subsidiary, and Walter C. Evans of Baltimore, Maryland, general manager of radio, x-ray and broadcasting divisions. All the new vice-presidents will continue in their present executive posts.

Dr. Yuster Receives Appointment by Compact Commission

Appointment of Dr. Samuel T. Yuster, State College, Pennsylvania, as the Pennsylvania member of the research and coördinating committee has been announced by Governor Leon C. Phillips of Oklahoma, chairman of the Interstate Oil Compact Commission.

Well-known in eastern petroleum circles, Dr. Yuster, since 1934, has been in the department of petroleum and natural gas engineering at Pennsylvania State College. At present he is associate professor of petroleum and natural gas engineering and in charge of petroleum production research in

the mineral industries experiment station. This research work is sponsored by the Bradford district research group and the Pennsylvania Grade Crude Oil Association; and studies are being conducted toward improving secondary recovery by water-flooding and air and gas drive.

Dr. Yuster, born December 21, 1903, in Manchester, England, attended public schools in Fargo, North Dakota. He obtained the bachelor of science degree in chemistry and chemical engineering from North Dakota State College in 1926. In 1934 he obtained from the University of Minnesota a doctor of philosophy degree with a major in physical chemistry and a minor in organic chemistry.

Dr. Yuster is chairman of the Eastern District of the American Petroleum institute sub-committee on core analysis and electrical logging. He is also a member of the A.P.I. Eastern District commitee on drilling and production practices and the committee on secondary recovery.

Dr. Yuster is the 10th member of the Interstate Oil Compact research and coördinating committee, which has technicians represented from Texas, Oklahoma, Arkansas, Colorado, Illinois, Kansas, Louisiana, Michigan, and New Mexico.

C.N.G.A. June Frolic Announced

The 1942 June Frolic of California Natural Gasoline Association will be held at the Altadena Golf Club, Altadena, California, Saturday, June 6, according to the announcement of W. C. Dayhuff, C.N.G.A. president.

The event, annually sponsored by the association, will be an all-day outing featuring golf, baseball, tennis, swimming, badminton, and volley ball. The Frolic will be topped off with a barbecued spare ribs buffet dinner to be followed with a stag show. Those desiring to attend should communicate with George L. Tyler, secretary, C.N.G.A., 510 West 6th Street, Los Angeles, California.

McLaughlin, Cowles Join Transportation Staff

The appointments of R. B. McLaughlin of Houston, Texas, as associate director of transportation, and Lee R. Cowles of Chicago, Illinois, as assistant director of transportation, Office of Petroleum Coördinator, have been announced by Deputy Coördinator Ralph K. Davies.

McLaughlin is vice-president and assistant manager of both The Texas Pipe Line Company and The Texas-New Mexico Pipe Line Company. He has a background of 36 years' experience in the transportation of petroleum and its products by pipe line. He first engaged in pipe-line activities in 1906, when he was employed by the pipe-line department of The Texas Company at Sour Lake, Texas.

A native of Fredonia, Pennyslvania, McLaughlin has been active in various industry associations, including the American Petroleum Institute. He is a member of the Institute's pipe-line valuation committee.

Cowles was traffic manager of the Standard Oil Company of Indiana before he joined OPC. He has been engaged for 20 years in the transportation of petroleum and petroleum products, principally by rail, motor transport, and inland waterways.

Establishes Branch at Centralia, Illinois

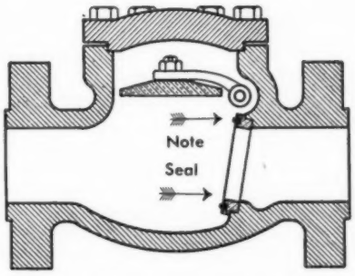
Western Machinery Company, representatives for Le Roi engines in the Illinois Basin, has recently established a branch office in Centralia.

Increased personnel together with the new and improved facilities enable the company to provide faster and better service for Le Roi engines, it is announced. A complete stock of Le Roi replacement parts is on hand for any emergency. This is of particular importance as it is difficult to obtain new engines and the present equipment must be kept in operating condition.

H. W. Magnus is branch manager and Bud Heidkamp is in charge of the service department at the Centralia branch.

Oil Men: *Help Yourselves! Use a Valve that is* SEALED *with* RUBBER *made from* OIL

FULL OPENING HORIZONTAL SWING CHECK VALVE
(with Synthetic Seal)



PATENT APPLIED FOR

Made in sizes from 2" to 16", and in Pressures from 125 lbs. to 1000 lbs. Flanged both ends; screwed both ends or flanged one end and screwed one end.

These valves are identical to the standard Wheatley check valves except that they are equipped with the Wheatley Synthetic Seal. This seal is a synthetic rubber ring which is dovetailed into the interchangeable valve seat and seals against the smooth face of the metal clapper. This pliable rubber will conform to any irregularities such as sand, scale or cuttings which might be deposited on the sealing surfaces.

The obvious advantage of our synthetic seal over the conventional type of valve is simply this. In applications where the line fluid contains grit, the conventional check valve will not seal perfectly and therefore will eventually cut out. The Wheatley synthetic seal check valve will seal perfectly at all times and therefore will have no tendency toward cutting out. Write for Bulletin No. C421A.

WHEATLEY BROS. PUMP & VALVE MFRS.
TULSA, OKLAHOMA

GET ACCURATE RESULTS
Quickly . . Easily . . with
CURTIN CENTRIFUGES

No. 3480 . . . 100 c. c. machine. Cranks and heads interchangeable with 15 c. c. machines.

You can maintain your required speed for the period of the test with much less effort. Curtin centrifuges, proven world-wide, are heavy duty, rigidly constructed, and extremely simple in design. Illustrated bulletin, giving full details, available upon request.

W·H·CURTIN & CO. Inc
HOUSTON U.S.A. TEXAS

REMOVE SCALE
While Boilers Operate
No shut-downs. No water analyses or mechanical cleanings.

Use SAND-BANUM
It safely, surely and economically removes old and prevents new scale and corrosion, with no work stoppage or delay.

"The Entirely Different Boiler and Engine Treatment"

Proof and "satisfaction or no money guarantee" details are yours for the asking.

AMERICAN SAND-BANAM COMPANY, Inc.
9 Rockefeller Plaza New York City

18,000 Miles of Wells Drilled in 1941

American oil men in 1941 drilled more than 18,000 miles of hole, the equivalent of a round-trip through the earth to China, with 2000 miles to spare, according to the A.P.I.

Depths of individual wells range all the way from a few hundred feet to nearly three miles. The number of deep wells, drilled to more than 10,000 ft., has been increasing spectacularly since the first one was completed in 1931, but the average depth of all wells has moved only a few feet up and down from 3000 ft. in the last 15 years.

Since 1931 the petroleum industry has drilled 1044 wells below 10,000 ft., 668 of them in 1940 and 1941. At the end of 1941, 60 others scheduled to pass 10,000 ft. were drilling.

The industry's heaviest and most modern equipment and materials are used to drill these deep wells. Not only have they discovered 63 new oil-producing formations, but they also have been of great importance in the development of new drilling techniques that are readily used in shallower drilling and in the advancement of knowledge of underground geological structures.

Of particular importance in the war emergency is the fact that most of the deep fields developed by these wells produce crude oil of extremely high gravity, which is most useful in the manufacture of super-aviation motor fuels. Thirteen new deep oil-producing formations were discovered in 1941.

Of the 361 deep wells completed last year, 247 were between 10,000 and 11,000 ft. deep; 97 were in the 11,000-ft. zone; 13 in the 12,000-ft. zone, and two each in the 13,000- and 14,000-ft. zones. The 15,004-ft. world's record well drilled in 1938 is the only one to pass 15,000 ft.

Two-thirds of the deep wells were drilled in Louisiana, which had 244 completions below 10,000 ft.; Texas had 74, California 39, and Alabama, Michigan, Mississippi, and West Virginia one each.

Appoints Representatives

Wheelco Instruments Company, Chicago, Illinois, has announced appointment of four new district representatives. Pasol Engineering Company has been named Iowa and Nebraska representative, with V. E. Lindquist in charge of the Iowa office at Des Moines, and I. I. Solzman heading the Nebraska office in Omaha. Fitzgerald, Inc., Wichita, has been assigned the Kansas territory, with Bloyce Fitzgerald in charge of instrument sales. Charles A. Drum, Houston, has been named Texas district manager.

Announcing..

HOTEL EDSON
BEAUMONT, TEXAS
Now an Affiliated
NATIONAL HOTEL
DUKE OSBORN, Manager

★ Enjoy the excellent accommodations of Beaumont's Finest—Texas' Tallest hotel. 350 spacious outside rooms, each equipped with tub or shower, servidor and circulating ice water. Excellent Coffee Shop.

ALABAMA
Hotel Admiral Semmes.....Mobile
Hotel Thomas Jefferson.....Birmingham
DISTRICT OF COLUMBIA
Hotel Washington.....Washington
ILLINOIS
Hotel Faust.....Rockford
LOUISIANA
Jung Hotel.....New Orleans
Hotel DeSoto.....New Orleans
MISSISSIPPI
Hotel Lamar.....Meridian
NEBRASKA
Hotel Paxton.....Omaha
NEW MEXICO
Hotel Clovis.....Clovis
OKLAHOMA
Oklahoma Biltmore.....Oklahoma City
Hotel Aldridge.....Wewoka
SOUTH CAROLINA
Hotel Wade Hampton.....Columbia
TEXAS
Hotel Alice.....Alice
Hotel Stephen F. Austin.....Austin
Hotel Edson.....Beaumont
Hotel Settles.....Big Spring
Hotel Brownwood.....Brownwood
Hotel Southern.....Brownwood
Hotel Laguna.....Cisco
Hotel Cortez.....El Paso
Hotel Texas.....Fort Worth
Hotel Buccaneer.....Galveston
Hotel Galvez.....Galveston
Hotel Jean LaFitte.....Galveston
Coronado Courts.....Galveston
Jack Tar Court.....Galveston
Miramar Court.....Galveston
Hotel Cavalier.....Galveston
Hotel Plaza.....Laredo
Hotel Lubbock.....Lubbock
Hotel Falls.....Marlin
Hotel Cactus.....San Angelo
Angeles Courts.....San Antonio
VIRGINIA
Mountain Lake Hotel.....Mountain Lake

★ ★ ★

Affiliated NATIONAL HOTELS
HOST TO THE NATION
SERVING 10 STATES AND OUR NATION'S CAPITAL

★ BUY U. S. DEFENSE BONDS ★

P 530.1

Oil Reservoir Behavior Based on Pressure-Production Data

A NEW method of evaluating the producing capacities of oil wells by comparing the amount of recovered petroleum with the decline of pressure in the reservoir has been suggested by U. S. Bureau of Mines engineers following an extensive study of reservoirs in different parts of the country.

It is stated that results of the investigation have provided a "new tool" useful in analyzing the performance of individual petroleum reservoirs and in determining the efficiency of operating methods, which is expected to be of considerable value in the current wartime emergency when production of oil to meet essential requirements, such as aviation gasoline, is desirable.

Described as a way to determine oil-reservoir behavior based upon pressure-production data, the Bureau's present study deals with conditions in representative oil fields in the states of Texas, Oklahoma, Arkansas, and New Mexico. The information obtained and the methods developed therefore should be applicable to reservoirs of similar types.

By plotting the cumulative decline of reservoir pressure against the cumulative amount of oil recovered, the presentation of a graphic logarithmic chart showing the relationship between them is possible, according to the report.

In explaining that the recovery of oil from the ground is an admittedly complex problem, the report points out that it involves a knowledge of the flow of fluids through underground porous mediums, as well as an understanding of the sources of energy responsible for the movement of oil and gas through reservoir sands and rocks to the wells. The efficient recovery of oil depends in a large part upon the manner in which reservoir energy is utilized to force the oil to the wells.

The three underground energy sources are internal gas expansion, natural water drive, and a combination of gas expansion and water drive. When a purely gas expansion reservoir is first tapped, a gas-pressure head drives oil to the well, but this pressure declines as oil and gas are withdrawn and this type of energy decreases continually with production.

In a water-drive reservoir the energy possessed by the oil and gas is due to pressure exerted upon them by a column of water in the extraneous parts of the reservoir system, and the decline of pressure is controlled by manipulating the rates of oil and gas production, and by additional water entering the water-bearing part of the reservoir. Most water-drive reservoirs pass through three stages of production during their oil-producing lives, the report reveals. The first is a short period during which oil and gas are forced to the wells by gas expansion, followed by a longer period when a combination of gas expansion and water-drive is the motivating agency, and ending with an extended era when a natural water drive is mainly responsible for movement.

In an effort to accumulate data that may aid operators to exploit and operate newer fields with greater efficiency, the Bureau engineers studied the pressure-production relations of a number of reservoirs on which longtime information data were available. They selected fields exhibiting a wide range of producing characteristics so that differences in their behavior would stand out prominently and invite analytical investigation.

Detailed descriptions of these fields, together with tables, charts and other pertinent information, are included in R. I. 3634, "Oil Reservoir Behavior Based on Pressure-Production Data," by H. C. Miller, which may be obtained without charge by writing the Bureau of Mines, Department of the Interior, South Building, Washington, D. C.

W. A. Minkler Promoted

William A. Minkler has been appointed sales manager of the Catalog Products Division of Young Radiator Company, according to an announcement by F. M. Young, president. Minkler has served as assistant sales manager since 1939, under M. F. May, vice-president in charge of heating, cooling, and air conditioning products. May will continue to supervise the catalog products sales program and, in addition, will do special work in connection with government and war effort activities to which the company is devoting most of its productive capacity during the present emergency.

In his new capacity, Minkler will direct Young Radiator's headquarters sales staff as well as the more than 60 sales representatives from coast to coast.

PIPE TONGS

Not only the type Tongs you want in the size and design you prefer — but the quality that distinguishes an "ARMSTRONG BROS." PIPE TOOL.

Chain Tongs with handles forged from high carbon steel, Drop Forged jaws with milled teeth, hardened, tempered and tested for wearing qualities, large Hardened Steel Bolts, Alloy Steel Shackles, proof-tested Chains, and the ARMSTRONG Design that gives far more bearing of jaws on bar.

All-Steel Pipe Wrench. This patented all-steel pipe wrench has 10 improved features including — elimination of cumbersome housing. Heavy forged-in lugs reinforced by reversed nut to take up side strain. Replaceable tool steel jaws. Perfect balance in all sizes. Try one and you will be satisfied with no other.

Armstrong Bros. Tool Co.
"The Tool Holder People"
331 N. Francisco Ave., Chicago, U.S.A.
Eastern Warehouse and Sales
199 Lafayette Street New York

DOES HOT WEATHER ROB YOU OF PRODUCTION?

You can curb loss of working efficiency through hot summer days. Fatigue often can be corrected with salt tablets. Frequent, time-wasting brow-mopping can be stopped with comfortable, cooling sweat pads.
Proper protection will overcome fears of ivy or oak poisoning, or snake bites for outdoor workers. These, and other time-savers are described in a new folder: "HOT WEATHER NEEDS That Aid Working Efficiency". 1B-5

E. D. BULLARD COMPANY
275 Eighth Street
San Francisco, California.
Everything BULLARD in Safety
Send new *free* folder: "HOT WEATHER NEEDS", outlining inexpensive methods of keeping up production through summer months.
Name _____
Address _____
City _____ *State* _____ PE
NATIONWIDE SALES AND STOCKS

Hiland Smith Joins Army Engineering Corps

Hiland R. Smith, formerly district manager for the Federal Oil Company, Dallas, Texas, in charge of drilling, production, pipe-line systems, tank farms, and pumping stations, has reported to Camp Claiborne, Louisiana, as a captain in the 331st Regiment, Engineering Corps, U. S. Army. As he is familiar with the territory from Rangoon to the Chinese Border, including all oil fields and 150 miles of coastal territory of British North Borneo from Sarawak north and speaks Hindustani, Burmese, and Malay, Captain Smith has applied for overseas duty.

HILAND R. SMITH

Smith began his career in the oil industry with his father, whom he describes as one of the "old wildcatters" in northern Ohio. He was assistant engineer with the Franklin Steel Company at Franklin, Pennsylvania, from 1909-10, leaving to go with Clauss, Brown and Wolfe in Kansas in the production branch of the industry.

In 1914 Smith was employed by the Netherland Colonial Petroleum Company, subsidiary of the Standard Oil Company of New Jersey, in British North Borneo. He served a year and a half of his contract before being forced to return to the States because of jungle fever. But in 1917, he again went overseas to British Burma for the Indo-Burma Petroleum Company, Ltd., and stayed until 1923. While in Burma he was in charge of production and development as assistant to Percy Corey. Smith drilled the discovery well of the Lanywa field of British Burma, approximately 100 miles south of Mandalay.

Returning to the states in 1923, Smith was employed as general manager in charge of development for the Oil Fork Development Company of Pittsburgh, Pennsylvania, in Kentucky and Tennessee until 1928, when he left that company and became affiliated with the Buell-Herndon Company, Tulsa, Oklahoma. As assistant to the vice-president of the company, Seth Herndon, Smith was instrumental in the development of the Valley Center field, Kansas, and the Bu-Vi-Bar pool

McEVOY
COMPANY
"OIL WELL EQUIPMENT" SINCE 1906
TEXAS AT MILBY • HOUSTON, TEXAS • TELEPHONE C-2288
SEE McEVOY'S 20 PAGE SECTION IN YOUR COMPOSITE CATALOG
CHRISTMAS TREES
COUNTER HYDROSTATIC GAS LIFTS
SCREENS
PACKERS • SET SHOES

Vortox
AIR CLEANERS
Important before—but vital today
—to maximum engine life!
Nowhere is engine protection more vitally important now than at the air intake system. And whether you operate large compressor engines, pumping engines, or smaller units such as those used on trucks and tractors, Vortox Air Cleaners can provide that protection dependably—safely—at low cost.
Vortox Air Cleaners have unusually large dust removing and dust holding capacities. Oil-washed filtering eliminates clogged inlets, maintains peak efficiency over exceptionally long periods. No cloth filters, nothing to require frequent replacement. A periodic oil change is the only upkeep required—an important maintenance point!
There's a Vortox Air Cleaner for gas, gasoline, or Diesel engines in the size and type for your needs. Capacities range from 5 to 8000 cu. ft. of air per minute. Make sure the engines you operate today will be operating tomorrow, too—specify Vortox!
VORTOX MANUFACTURING CO., CLAREMONT, CAL.
VORTOX
OIL TYPE SELF-WASHING
AIR CLEANER

near Perry, Oklahoma. Smith was in the East Texas fields for the company until 1934 at which time he was employed by the Federal Oil Company. He has supervised drilling of more than 65 wells in Jack and Young counties of northwest Texas.

Cooper-Bessemer Expanding

New buildings and equipment, which will practically double its productive capacity of Diesel engines, are reported being erected by The Cooper-Bessemer Corporation of Mount Vernon, Ohio, at its Grove City, Pennsylvania, plant.

Announcement of the new expansion was made by B. B. Williams, Cooper-Bessemer president and board chairman. The project is financed under a plant facilities contract authorized by the Bureau of Ships, Navy Department.

Principal element involved in the present project is construction of two new buildings that will vacate, for increased Diesel engine production, space heretofore utilized for storage.

One of the new buildings containing 4 bays, two of which are 30 ft. by 180 ft., one 40 ft. by 280 ft., the other 40 ft. by 140 ft., will be integral with the main manufacturing portion of the present plant. It will be used for storage of materials and for shipping.

The other structure will adjoin the present pattern storage building and will double the plant's pattern storing facilities.

Commenting on the expansion program, Williams said, "The sky would be the limit except for the critical shortage of skilled workers. Our Grove City plant draws its employees from a radius of 25 miles and the inability to obtain skilled workers as rapidly as they can be absorbed places a ceiling on our program of expansion, at least, until this shortage is remedied."

The Cooper-Bessemer Corporation, one of the nation's oldest engine building concerns, having begun business in 1833, has been operating at full capacity for many months.

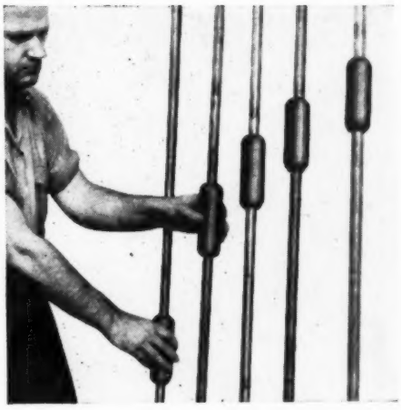
W. F. Humphrey Receives Government Appointment

Petroleum Coördinator Harold L. Ickes has announced the appointment of William F. Humphrey, president of Tide Water Associated Oil Company, as general chairman of the General Committee for District Five of the petroleum industry, including the states of Arizona, California, Nevada, Oregon, Washington, and the Territories of Alaska and Hawaii.

Humphrey succeeds to the position formerly held by A. L. Weil, whose resignation was recently accepted by Ickes.

In making the appointment, Ickes pointed out that Humphrey is thoroughly familiar with the district organization arrangement, which provides for a general committee in each of five districts.

Slideable Sucker Rod Protectors



Rod Type
•
Molded or Polished
•
Made of Special Plastic
•

Patterson-Ballagh Rod Style Sucker Rod Protectors are for severe service. They are molded directly onto polished rods of a standard "pony rod." The rod slides inside the Protector instead of against the rough tubing problem. Reduced pumping load. Length of Protector, 6".

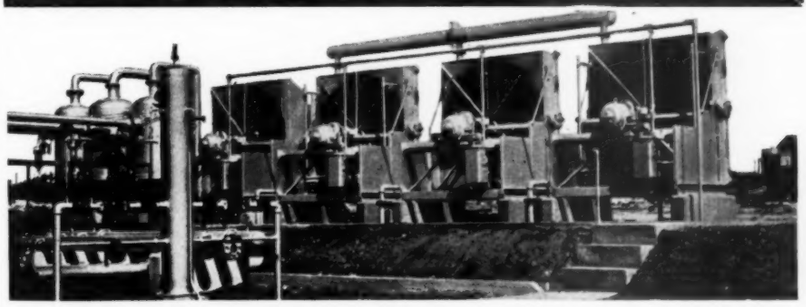
See Composite Catalog

PATTERSON-BALLAGH SUCKER ROD PROTECTORS

PATTERSON - BALLAGH CORPORATION

LOS ANGELES HOUSTON NEW YORK CITY

HIGH COOLING CAPACITY with LOW POWER CONSUMPTION



This battery of YOUNG Engine Jacket Water Coolers is doing an outstanding job cooling gas engines and compressors on an 800 H.P. installation of the Continental Oil Company, located at Benavides, Texas. Engineers look to YOUNG to solve their cooling problems for all types of internal combustion engines.

YOUNG Units are designed to give maximum cooling efficiency with a minimum of power consumption for pump or fan. Why not let us apply our complete research and engineering facilities to your cooling problem? Write today for information.

YOUNG RADIATOR COMPANY, Dept. 282-E, Racine, Wisconsin, U.S.A.
Mid-Continent Distributor: **THE HAPPY COMPANY, Tulsa, Oklahoma**
Pacific Coast Distributor: **A. R. FLOURNOY, Bell, California**

Young HEAT TRANSFER PRODUCTS
OIL COOLERS • GAS, GASOLINE, DIESEL ENGINE COOLING RADIATORS • INTERCOOLERS • HEAT EXCHANGERS • ENGINE JACKET WATER COOLERS • UNIT HEATERS • CONVECTORS • CONDENSORS • EVAPORATORS • AIR CONDITIONING UNITS • HEATING COILS • COOLING COILS

Young SERVICE

DO NOT THROW AWAY YOUR WORN "TOLEDO" TOOLS OR DULL "TOLEDO" DIES

IT IS QUITE PROBABLE THESE WORN TOOLS CAN BE REPAIRED AND THE DULL DIES CAN BE RESHARPENED TO GIVE ADDITIONAL SERVICE, CONSERVING STEEL AND OTHER VITAL METALS NEEDED FOR WAR PRODUCTION.

WE SHALL WIN THIS WAR, BUT TO WIN WE ALL MUST CO-OPERATE TO THE FULLEST EXTENT. DO YOUR PART. SAVE—SAVE.

THE TOLEDO PIPE THREADING MACHINE CO.
TOLEDO, OHIO • *New York Office:* No. 2 Rector Street

"TOLEDO"
MAKERS OF FINE
PIPE TOOLS, POWER PIPE MACHINES, VISES, BENCHES

ENSIGN Carburetion

Natural Gas is the ideal fuel for stationary internal combustion engines. Natural Gas as a fuel does not present the problems of carbon, foul odors, crank-case dilution, high manifold heat and distribution of wet fuels, such as gasoline. • Natural Gas carburetion, properly installed, results in remarkable savings in over-all cost of operation, decreased fuel cost, decreased maintenance and increased engine efficiency. • Accurate proportioning of gas-air mixtures is vitally essential. The ENSIGN Fuel Regulator and Gas Carburetor combine to make a highly efficient controlled mixture of fuel and air required for maximum engine performance. • Standard equipment with approximately 90% of the leading engine manufacturers, ENSIGN Carburetors assure dependable, economical engine operation for oil well drilling, servicing, pumping, auxiliary equipment and all other engine uses.

ENSIGN CARBURETOR CO., LTD.
HUNTINGTON PARK, CALIF. • DALLAS, TEXAS • CHICAGO, ILL.

TRADE LITERATURE

What to Write For

BULLETIN 1079 will be released on request by Waukesha Motor Company, Waukesha, Wisconsin. The bulletin contains ratings, speed, torque, and other information on the Waukesha engine from 410 to 10 hp.

THE PETROLEUM RECTIFYING COMPANY of California, Los Angeles, will send the Petreco bulletin, "Determination of Salts in Crude Oils," on request.

A NEW BOOKLET on pipe and fittings will be sent without obligation by the National Carbon Company, Inc., 30 East 42nd Street, New York, New York, manufacturers of "Karbate" pipe and fittings.

"THE BOOK OF PIPE PROTECTION" is offered the reader without cost or other obligation by General Paint Corporation, Hill, Hubbell and Company Division, Cleveland, Ohio. The book describes the company's process in detail for steel pipe protection.

A 44-PAGE CATALOG of useful information on packing will be sent free by The France Packing Company, Tacony, Philadelphia, Pennsylvania. Write for Catalog M-3.

CHIKSAN ball-bearing swing joints for refinery applications are described in the company's Catalog No. 41. The catalog describes the low-pressure, high-pressure, high-temperature, and dock riser and marine hose type swing joints. Address Chiksan Tool Company, Brea, California.

THE CHAPMAN VALVE MANUFACTURING COMPANY, Indian Orchard, Massachusetts, offers a completely descriptive bulletin on the Chapman Non-Slam Check Valves for increased operating efficiency in refineries and on natural gas lines.

FEATURES of the synthetic seal check valve are explained in Bulletin No. C421A being released by Wheatley Bros. Pump and Valve Manufacturers, Tulsa, Oklahoma.

A WRITTEN REQUEST will bring Tube-Turns' helpful engineering data book and catalog describing Tube-Turns welding fixtures. Address Tube-Turns, Inc., Louisville, Kentucky.

A CATALOG describing filters for engines, pipe lines, ventilation, etc., may be had by addressing Staynew Filter Corporation, 2 Centre Park, Rochester, New York.

FOR FULL INFORMATION on low-cost, high-capacity, bearings, write Bantam Bearings Corporation, South Bend, Indiana, manufacturers of straight roller, tapered roller, needle, and ball bearings. Ask for Bulletin P-104.

FOSTER WHEELER CORPORATION, 165 Broadway, New York, has issued a new 80-page bulletin, 0-42-1. Described are refinery installations and various processes and products; also many of the individual items of equipment going into processing plants.

THE BROWN INSTRUMENT COMPANY announces the addition of the Brown Absolute Pressure Gauge to its line of industrial indicating, recording, and control instruments. Bulletin No. 70-11 fully describes this new instrument. Address The Brown Instrument Company, Wayne and Roberts Avenues, Philadelphia, Pennsylvania.

WRITE TO DOWELL INCORPORATED, Midland, Michigan, for complete information on the company's formation cleaner service to release entrapped water, dissolve asphaltic, paraffinic, and sedimentary materials and free them from the critical area near the well bore. A copy will be sent without obligation.

A 64-PAGE 1942 revision of the "Quick Selector Catalog" is announced by the Westinghouse Electric and Manufacturing Company. Issued twice a year, this catalog has become extremely popular, as it simplifies the selection of many types of electrical equipment. A copy of the April, 1942, "Quick Selector Catalog" 30-000 may be obtained from department 7-N-20, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pennsylvania.

THE WORTHINGTON PUMP AND MACHINERY CORPORATION, Harrison, New Jersey, offers its bulletin S-550-B20 on the Worthington BBG vertical 4-cycle gas engine, "of the simplest and most compact design consistent with high efficiency and complete accessibility." The bulletin will be sent on request without obligation.

A COMPLETE SET of descriptive literature of a new-style bulletin covering the entire line of "Oilwell" pumping units, as well as certain other bulletins, are available at all "Oilwell" stores and offices or may be obtained by writing to the company's general offices at Dallas, Texas. Bulletin H1-442, No. 2000-CT combination head; H2-442, No. 2000 stuffing-box casinghead; J2-442, No. 12-A pumping jack; U6-442, TC-23H and TC-33H pumping units; and U7-442, TC-12H and TC-17C pumping units. Address Oil Well Supply Company, Dallas, Texas, for a copy of these bulletins.

READERS ARE ASKED to write for a copy of a bulletin describing the new Tuboscope, the modern scientific internal tubular inspection service that, according to the manufacturer, actually tells the condition of pipe—drill pipe, drill collar, kelly stem, casing, line pipe, and tubing. Address Tuboscope, Houston, Texas; New Iberia, Louisiana; Odessa, Texas; Great Bend, Kansas, and Mt. Vernon, Illinois.

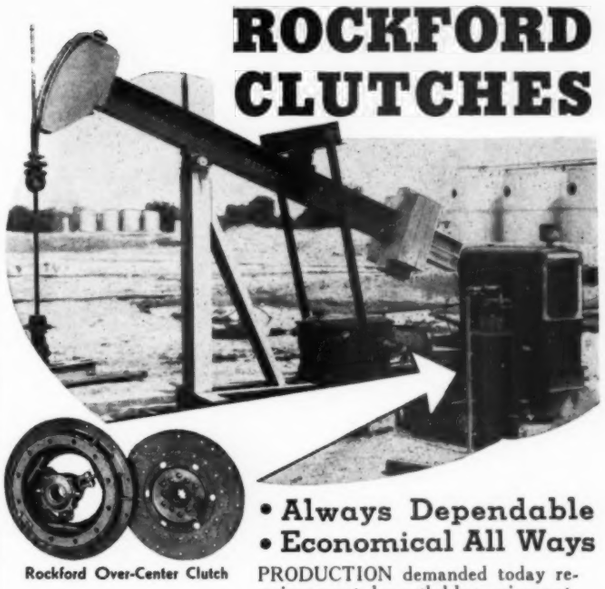
PENBERTHY INJECTOR COMPANY offers its Catalog 34-A on the Penberthy gauges. The catalog contains information on the company's Transparent and Reflex, drop-forged steel liquid level gauges, the Reflex water gauge set, and the drop-forged steel liquid level gauges of chromium-molybdenum alloy temperature-resisting steel, extra heavy throughout. Address Penberthy Injector Company, Detroit, Michigan.

A CATALOG, No. 41, on Reed Valves is being released by the Reed Roller Bit Company, Reed Valve Division, Post Office Box 2119, Houston, Texas, on request. According to the manufacturers, operators may easily reduce valve maintenance costs with the Reed Valve.

"ROPE DOPE," an informative wire rope periodical, will be sent on request without charge. For a copy address the Union Wire Rope Corporation, 2106 Manchester Avenue, Kansas City, Missouri.

DETAILS OF THE J-M 420 Rotary Lining are contained in the brochure FM-10A. J-M 420 can be relied on to provide an unusually even feed-off and easy load control with rim scoring minimized, according to the manufacturer. Address Johns-Manville, 22 East 40th Street, New York, New York.

COMPLETE INFORMATION on the Cycoil air cleaners is contained in the Cycoil Bulletin No. 130D and will be sent on request. Address American Air Filter Company, Inc., 384 Central Avenue, Louisville, Kentucky.



ROCKFORD CLUTCHES

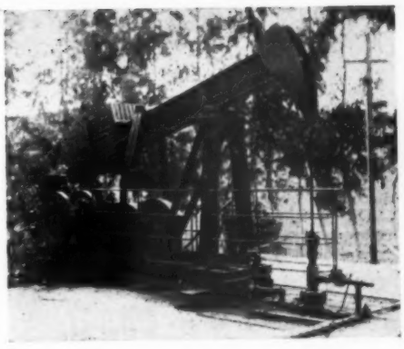
Rockford Over-Center Clutch

• Always Dependable
• Economical All Ways

PRODUCTION demanded today requires most dependable equipment. Dependability of Rockford Clutches, always notable, is proving itself anew continually throughout the oil industry in power units, tractors, trench-diggers, back-fillers, pumping and other equipment. Rockford Clutches are economical all ways, too. Clutch-operated equipment must now work harder and last longer than ever — so specify Rockford Clutches when buying. When over-hauling — use Rockford Clutches, made in Spring-Loaded and Over-Center types up to 80 h.-p. capacity.

Rockford Drilling Machine Divison Borg-Warner Corporation
▼ 1303 Eighteenth Avenue, Rockford, Illinois, U. S. A. ▼

Fullmore Multiple-Disc Clutches • Over-Center and Spring-Loaded Clutches • Power Take-Offs



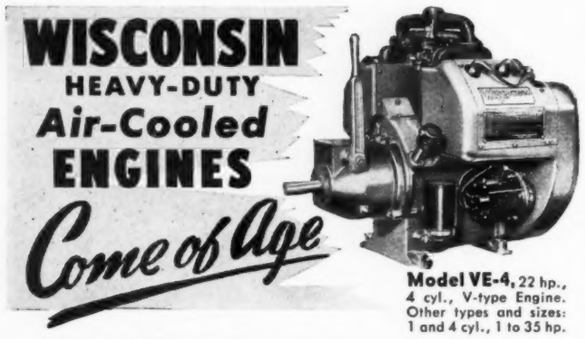
Adolph and Hirohito wouldn't like **JENSEN JACKS!**

Adolph and Hirohito wouldn't like JENSEN JACKS—not for American producers. The initial cost is too low. Installation is too simple. They conserve too much power. They last too long with too little maintenance.

But to hell with Adolph and Hirohito! Wire us at Coffeyville or get in touch now with your JENSEN dealer.

JENSEN BROTHERS MFG. CO.
Coffeyville, Kansas, U. S. A.
Export Office: 50 CHURCH STREET, NEW YORK CITY

Enjoy this mountain wonderland... stay in Denver close to all activities, shops and entertainment facilities...Friendly atmosphere...LOW COST. Dining Room, Coffee Shop, Shirley Tavern. Also Shirley Garage.



Model VE-4, 22 hp., 4 cyl., V-type Engine. Other types and sizes: 1 and 4 cyl., 1 to 35 hp.

"Old enough to vote", in terms of continuous production and development, Wisconsin heavy-duty air-cooled engines have also definitely *come of age* from the standpoints of industrial recognition and acceptance.

It has taken the hard proof of *service*, under the most trying operating conditions, in many lines of industry and power applications . . . to convince designing engineers, equipment manufacturers, and tough-skinned users that AIR-COOLED ENGINES, properly designed and built, *cause less trouble and provide higher productive capacity* than any other type of internal combustion unit within 35 hp. limits.

More than 300 machine manufacturers use Wisconsin Heavy-Duty Air-Cooled Engines as standard power equipment . . . covering *your* field as well as many others.

MOST POWER Per POUND

WISCONSIN MOTOR Corporation
MILWAUKEE, WISCONSIN, U. S. A.
World's Largest Builders of Heavy-Duty Air-Cooled Engines

WRITE TO HARLEY SALES CO.
510 ATLAS BLDG., TULSA, OKLA.
M & M BLDG., HOUSTON, TEXAS
OIL FIELD DISTRIBUTOR FOR WISCONSIN ENGINES AND ALL TYPES OF UTILITY UNITS

Fred Ripley Granted Leave of Absence By Emsco

Fred C. Ripley, Jr., has obtained a leave of absence from his present duties as manager of export sales for Emsco Derrick and Equipment Company, Los Angeles, California, for the duration of the war. In making formal announcement of this move, Hugh Glen, president of Emsco, states it is Ripley's desire to become more closely and actively affiliated with the actual war effort than his present duties permit, and although the company is extensively engaged in war work in its manufacturing divisions, present export and shipping conditions have not provided him with that opportunity.

FRED C. RIPLEY, JR.

"Rip" is one of the best known export men in the oil industry, having been export manager for Emsco over a period of five years, and has made a number of trips to various foreign countries during that time for the company and its distributor, Continental Emsco Company. He is a charter member of the Los Angeles Chapter of Nomads.

E. B. FOWKS

R. O. PERRY

Ripley is an ardent yachting enthusiast, and his talents being decidedly along nautical lines, he very likely will proffer his services to the Naval branch of the armed forces where he feels he can serve most effectively.

E. B. "Ernie" Fowks, present manager of patents, sales promotion and advertising, has been appointed manager of export sales for Emsco Derrick and Equipment Company during Ripley's absence. He will relinquish his duties in connection with advertising and sales promotion but will retain the management of patents.

Having previously served in this same capacity for the company, and because of his many years of experience in various departments of the Emsco organization, Fowks is exceptionally well qualified to take over this work. Through numerous business trips to other countries during recent years, he enjoys a wide acquaintance among oil men in foreign fields, as well as in the United States where he has been affiliated with the petroleum industry for many years.

Fowks also is a charter member of the Los Angeles Chapter of Nomads, having occupied various executive offices, including that of president during 1941; and at present is a member of the national board of regents.

R. O. Perry has been appointed manager of advertising and sales promotion for all divisions of the company including the D + B Division. Perry has been with the D + B Division of Emsco Derrick and Equipment Company for the last seven years and has been connected with the oil industry for many years.

MEETINGS

American Petroleum Institute, 12th Mid-Year Meeting—May 25, 26, 27, 28, and 29, Oklahoma City, Oklahoma. (Cancelled)

California Natural Gasoline Association, Monthly Meeting—June 4, Barker Bros. Auditorium, 818 West Seventh Street, Los Angeles, California.

Illinois-Indiana Petroleum Association and Illinois Basin Chapter of American Petroleum Institute, Joint Petroleum Conference—June 6, Robinson, Illinois.

American Society of Mechanical Engineers, Semi-Annual Meeting—June 8, 9, 10, and 11, Cleveland, Ohio.

North American Gasoline Tax Conference, Regional Conference—June 19, New York, New York.

American Society for Testing Materials—June 22, 23, 24, 25, and 26, Chalfonte-Haddon Hall, Atlantic City, New Jersey.

Indiana Independent Petroleum Association, Fall Meeting—September 14 and 15.

National Petroleum Association, Annual Meeting—September 16, 17, and 18, Hotel Traymore, Atlantic City, New Jersey.

Texas Mid-Continent Oil and Gas Association—October 8, 9, and 10, Dallas, Texas.

American Society of Mechanical Engineers, Fall Meeting—October 12, 13, and 14, Rochester, New York.

Indiana Independent Petroleum Association—October 14 and 15, Hotel Severin, Indianapolis, Indiana.

National Stripper Well Association, Annual Meeting—October 19, Wichita, Kansas.

Independent Petroleum Association of America, 13th Annual Meeting—October 20, 21, and 22, Wichita, Kansas.

National Lubricating Grease Institute, Tenth Annual Meeting—October 25, 26, 27, 28, and 29, New Orleans, Louisiana.

Illinois Mineral Industries Conference—October 30 and 31, Urbana, Illinois.

American Petroleum Institute, Annual Meeting—November 9, 10, 11, 12, and 13, Chicago, Illinois.

American Institute of Chemical Engineers, 35th Annual Meeting—November 16, 17, and 18, Netherland Plaza, Cincinnati, Ohio.

PROVED IN SERVICE . . .

TWELVE years of successful use on oil field equipment point to Elastic Stop Nuts as the fastenings that can be relied upon to hold tight under all operating conditions.

» Write for folder explaining the Elastic Stop principle . . . and see data in Composite Catalog.

ELASTIC STOP NUT CORPORATION
2365 VAUXHALL ROAD • UNION, NEW JERSEY

Elastic Stop SELF-LOCKING NUTS

Gotkool
WATER CANS & COOLERS

GOTKOOL WATER CAN
Made in 1½, 2, 3, 5, 10, 15 and 20 gallon sizes. Furnished with push-button faucet at slight additional cost.

GOTT Water Cans are the practical way to keep drinking water cool for long periods, protected from impurities and always handy to the job. Snug fitting large removable top, strongly built to withstand rough usage. GOTT Water Coolers have extra large covers and a handy non-leaking push button faucet. Your Supply Store has them, get one today! . . . . .

GOTKOOL WATER COOLER
Made in 2, 3, 5, 8, 10, 15 and 20 gallon sizes.

H. P. GOTT MFG. CO.
WINFIELD, KANSAS

KEEP PURE DRINKING WATER ALWAYS HANDY

Renew Your Subscription

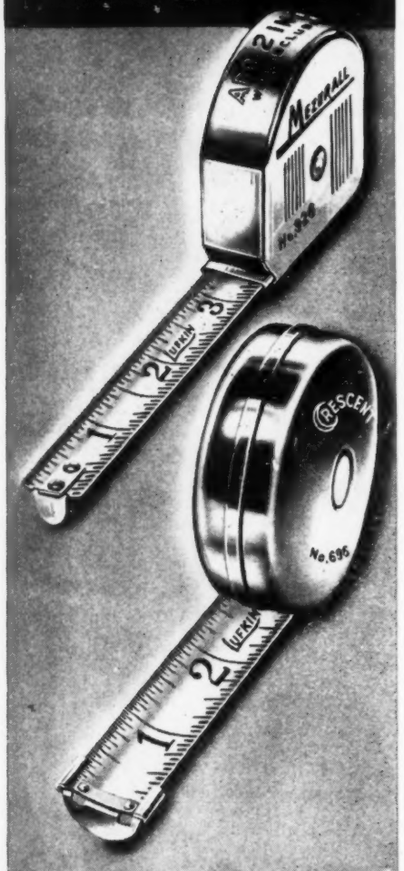
IF YOU WANT A PACKING THAT FITS THE JOB USE Durametallic

Protect your pump investment . . . prevent wear on rods, shafts and sleeves and costly shut-downs by using DURAMETALLIC . . . the original twisted, flexible, lubricated, metallic packing. Free Engineering Service.

WRITE FOR SPECIFICATION SHEETS

DURAMETALLIC CORPORATION
The PERFECT SEAL
KALAMAZOO MICHIGAN

SAVE TIME WITH
LUFKIN
TAPE-RULES



Every busy oilman needs a Tape-Rule for his vest pocket —where it's handy and ready for those dozens of little measuring jobs that come up every day. There's no need wasting time to search for a tape or in trying to guess the measurement. Just reach in your pocket for your "Mezurall" or "Crescent." Your dealer can help you select the one you need.

LUFKIN
SAGINAW, MICHIGAN • New York City
TAPES · RULES · PRECISION TOOLS

Index to Advertisers

Abercrombie Pump Co. 203
Acme Fishing Tool Co. 203
Affiliated National Hotels 210
American Air Filter Co., Inc. 126
American Blower Corp. 202
American Cable Division of American Chain and Cable Company, Inc. Inside Back Cover
American Chain & Cable Company, Inc. Inside Back Cover, 53 and 95
American Hammered Piston Ring Division 69
American Meter Company 5
American Roller Bearing Co. 48
American Sand-Banum Co., Inc. 210
Armstrong Bros. Tool Co. 211
Axelson Manufacturing Co. 207

B and W, Inc. 208
Baash-Ross Tool Co. 45
Badger, E. B., & Sons Co. 100-101
Bantam Bearing Corp. 174
Baroid Sales Co. 12
Bartlett-Hayward Division 69
Bethlehem Supply Company 91
Braden Steel Corp. 106
Brown Instrument Co. 89
Buckeye Traction Ditcher Co. 153
Bullard, E. D., Co. 211

Cameron Iron Works 163
Cardwell Mfg. Co. 1
Case, J. I., Co. 191
Chapman Valve Mfg. Co., The 182
Chicago Bridge & Iron Co. 19
Chiksan Tool Co. 176
Clark Bros. Co. 59, 110-111
Cleveland Trencher Co. 201
Continental Motors Corp. 194
Continental Supply Co., The 146
Cook, C. Lee, Mfg. Co. 25
Cooper-Bessemer Corp. 37
Crane Co. 8
Cummins Engine Co. 155
Curtin, W. H., & Co. 210

Dowell Incorporated 21
Durametallic Corp. 217

Elastic Stop Nut Corp. 217
Electro Metallurgical Co. 113
Emsco Derrick & Equipment Co. 151
Ensign Carburetor Co., Ltd. 214

Fluid Packed Pump Co. 157
Fluor Corp., Ltd. 75
Foster Wheeler Corp. 129
France Packing Co. 204
Franks Mfg. Corp. 43

Gaso Pump & Burner Mfg. Co. 67
Gasoline Plant Construction Corp. 148
General Paint Corp. 196
Gott, H. P., Mfg. Co. 217
Garver Tank & Mfg. Co., Inc. 134
Grizzly Manufacturing Co. 193
Guiberson Corporation 65
Gulf States Utilities Co. 206

Halliburton Oil Well Cementing Company Back Cover
Harrisburg Steel Corp. 57
Hazard Wire Rope Division of American Chain and Cable Co., Inc. 53
Hill, Hubbell & Co., Division 196
Hughes Tool Co. 54
Hyatt Bearings Division, General Motors Sales Corp. 186

Ingersoll-Rand 63

Jensen Bros., Mfg. Co. 215
Johns-Manville Corp. 143

Jones, S. M., Co. 200
Keuffel & Esser Co. 119
Kobe, Incorporated 61
Koppers Company 69
American Hammered Piston Ring Division, Bartlett Hayward Division, Engineering and Construction Division, Western Gas Division, Wood Preserving Corp., The

Lane-Wells Company 2
LeRoi Company 180
Leschen, A., & Sons Rope Co. 15
Linde Air Products Co., The 85
Link-Belt Co. 159
Lone Star Cement Corp. 41
Lufkin Rule Co 218
Lummus Co. 121-122
Lunkenheimer Co., The 205

McEvoy Company 212
Macwhyte Company 3
Marmon-Herrington Co. 6
Martin, John N., Manufacturer 195
Merco-Nordstrom Valve Co. 103-104
Midwest Piping & Supply Company, Inc. 87
Mission Mfg. Co. 165

National Carbon Company, Inc., Carbon Sales Division 93
National Supply Co., The 161
Nelson Electric Manufacturing Co. 145

Oakite Products, Inc. 145
Otis Pressure Control, Inc. 189

Patterson-Ballagh Corporation 213
Penberthy Injector Co. 17
Petro-Chem Development Co. 133
Petroleum Electric Power Assn. 98
Petroleum Rectifying Co. 125
Pittsburgh Equitable Meter Co. 170

Reading-Pratt & Cady Division of American Chain & Cable Co., Inc. 95
Rector Well Equipment Co., Inc. 167
Reed Roller Bit Co. 26 and 141
Reilly Tar & Chemical Corp. 198
Republic Steel Corp. 7
Ridge Tool Co. 184
Rockford Drilling Machine Division 215

Shirley-Savoy Hotel 216
Smith, A. O., Corp. Inside Front Cover
Sperry-Sun Well Surveying Co. 9
Staynew Filter Corp. 139
Stratford Engineering Corp. 137

Taylor Forge & Pipe Works 97
Texaco Development Corp. 117
Toledo Pipe Threading Machine Co. 214
Tretolite Co. Front Cover
Tube-Turns, Inc. 115
Tulsa Boiler & Machinery Co. 70
Twin-Disc Clutch Co. 197

Union Carbide and Carbon Corp. 85, 93, 113
Union Wire Rope Corp. 192
U. S. Treasury Dept. 10

Vortox Manufacturing Company 212

Wall-Colmonoy Corp. 199
Waukesha Motor Company 47
Webster Engineering Co. 81
Westinghouse Electric Mfg. Co. 78-79
Wheatley Bros. Pump & Valve Mfrs. 209
Whitney Chain & Mfg. Co., The 178
Williams, J. H., & Co. 169
Wilson Supply Co. 23
Worthington Pump & Machine Corp. 131

Young Radiator Co. 213
Youngstown Sheet & Tube Co. 13